

HANDBOOKS OF AMERICAN NATURAL HISTORY

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Handbook of Salamanders

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Part 2

the snout, and this is followed by the deposition of spermatophores. The eggs are deposited in masses and attached to twigs and weed stems below the surface of the water. The egg mass may be globular, oblong, or kidney-shaped, and measure from $2\frac{1}{4}'' \times 2\frac{3}{4}''$ (55 x 70 mm.) to $3 \times 4''$ (75 x 100 mm.). The eggs average about 52 per mass but vary from 23 to 110. Compared with that of *A. maculatum*, the egg mass of the Tiger salamander has the common jelly envelope thicker but less dense, the eggs fewer in number, the individual envelopes with a greater diameter. The vitellus has a diameter of 3 mm., the upper pole light- to dark-brown and the lower pole pale cream to buff. There are 3 distinct envelopes in addition to the vitelline membrane. The extent of the incubation period is variable, 24-30 days or longer.

LARVAE. Larvae at hatching average about $\frac{9}{16}''$ (14 mm.) but vary from 13 to 17 mm. The head of the young larva is broad, widest in front of the gills, and rounding to the short blunt snout. The gills are as long as the head and with few filaments. The dorsal keel extends backward from the head and is continuous with that of the tail. The balancers and limbs are lacking at hatching, and the forelegs represented by low humps. The ground color above is yellowish-green with some darker markings. On either side of the middorsal line there is a dark band, usually broken to form about 6 pairs of dark spots. Normally a light band extends along each side from the eye well onto the tail. The larvae may attain a length of $3\frac{9}{16}''$ - $4\frac{7}{8}''$ (90-123 mm.) by June in the North, after a development period of 75-118 days. Sexual maturity may be reached the spring following transformation.

DEVIL'S LAKE TIGER SALAMANDER. *Ambystoma tigrinum diaboli* Dunn.

Fig. 43. Map 20.

TYPE LOCALITY. Devil's Lake, North Dakota.

RANGE. North Dakota (north and east of Altamount Moraine) into Alberta, Saskatchewan, and Manitoba.

SIZE. Attains a maximum size of $12\frac{1}{4}''$ (312 mm.). The average of 15 adults of both sexes from the vicinity of Turtle Mountain and Devil's

Lake, North Dakota, is $7\frac{1}{2}''$ (190 mm.), with extremes of $11\frac{1}{8}''$ (282 mm.) and $4\frac{1}{16}''$ (119 mm.). The proportions of the Devil's Lake female are as follows: total length $11\frac{1}{8}''$ (282 mm.), tail $5\frac{5}{32}''$ (131 mm.); head length $1\frac{2}{32}''$ (42 mm.), width $1\frac{7}{16}''$ (37 mm.). An adult male from near Lake Upsilon, North Dakota, measures: total length $8\frac{3}{4}''$ (222 mm.), tail $4\frac{3}{8}''$ (111 mm.); head length $1\frac{7}{32}''$ (31 mm.), width $1\frac{1}{16}''$ (27 mm.).

HABITAT. Both adults and larvae are known from the fresh-water lakes in North Dakota and from Devil's Lake, which has a high salt concentration; but the species has been reported as breeding only in fresh water.

DESCRIPTION. The head is broad, convex above behind the eyes, widest opposite the angle of the jaws; the sides behind the eyes converge slightly to the gular fold; the snout depressed and bluntly rounded. The eye is relatively small, its horizontal diameter about 3 times in the snout. An impressed line from the posterior angle of the eye to the lateral extension of the gular fold; a vertical groove from this line to the angle of the mouth. Gular fold strongly developed. Trunk widened ventrally, somewhat narrowed dorsally, and with an impressed median line. Usually 12 costal grooves, or 13 counting 1 in the axilla and 2 that run together in the groin, and 1-3 intercostal folds overlapped by the toes of the appressed limbs. Tail widest at about the basal third, basal half rounded below, compressed above; distal half strongly compressed. Legs large, stout; toes 5-4, those of the hind feet 1-5-2-3-4 in order of length from the shortest; toes of the fore feet 1-4-2-3. Toes flattened and pointed, with flange-like margins, the tips black and horny; hind toes one-half webbed, fore feet webbed at base. Plantar and palmar tubercles well developed. Tongue nearly circular in outline, the parallel plicae narrow and extending to the anterior margin from a posterior field which is crossed by several crescentic folds. Vomerine teeth small and in 2 or 3 irregular rows forming a wide V-shaped figure, the apex directed forward.

COLOR. I have not seen this species in life. In preserved specimens the ground color above varies from gray to brown and light olive, lighter

on the sides and dull yellowish below. This species is marked with many small rounded black spots, which in some individuals may become somewhat elongate on the sides of the trunk; a few black spots on the throat,

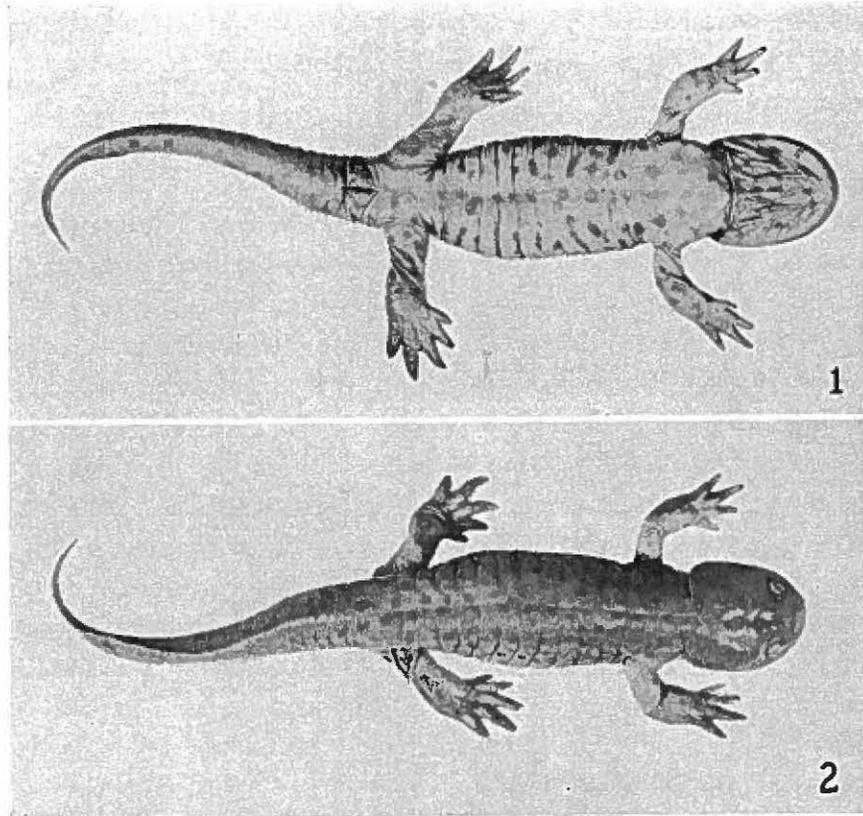


FIG. 43. *Ambystoma tigrinum diaboli* Dunn. (1) Adult female, ventral view; actual length $8\frac{3}{8}$ " (213 mm.). (2) Same, dorsal view. Near Lake Upsilon, North Dakota. [Photographs of a preserved specimen.]

sides of the belly and under surface of the limbs. In some the black spots on the belly may be elongate and arranged transversely. Some specimens from near St. Johns, North Dakota, have a strongly mottled appearance, the dark spots showing a tendency to run together on the sides and belly, and occasionally on the back.

BREEDING. A large female from Devil's Lake, North Dakota, unfortunately without the date of collection, has large ovarian eggs apparently ready to be deposited. The eggs are pigmented above (brown in preservative) and yellowish below. Apparently this subspecies is often neotenic.

LARVAE. The larvae attain a large size and when fully grown have the general color and pattern of adults. A series of 11 from Sweetwater Lake, North Dakota, varied in length from $5\frac{2}{3}$ " (151 mm.) to $7\frac{1}{8}$ " (181 mm.) and averaged $6\frac{5}{8}$ " (168 mm.). The broad dorsal tail fin arises at the back of the head and is widest at a point just behind the vent. The ventral fin extends to the vent. The gills are long and slender, 1-2-3 in order of length from the anterior. In some specimens there is a tendency for the dark spots to form bars on the tail.

Partly grown larvae from Grand Forks, North Dakota, vary in length from $3\frac{19}{32}$ " (92 mm.) to $4\frac{7}{32}$ " (108 mm.). These either exhibit a marbled pattern or have the dark pigment concentrated in fairly definite spots. The dorsal tail keel is strongly blotched, the ventral fin relatively free from darker markings. On some individuals there is a well defined row of light spots on the sides, extending from the head onto the basal half of the tail; in a few specimens a secondary row of light spots on either side of the dorsal fin.

YELLOW-BARRED TIGER SALAMANDER. *Ambystoma tigrinum mavortium* Baird. Fig. 44. Map 20.

TYPE LOCALITY. New Mexico.

RANGE. Kansas, Oklahoma, central and western Texas, eastern Colorado, central and eastern New Mexico (Dunn, 1940, p. 158).

SIZE. The average length of 16 adults of both sexes from Kansas and Oklahoma is $6\frac{2}{32}$ " (171 mm.). Five adult males average $7\frac{9}{16}$ " (192 mm.), the extremes $5\frac{19}{32}$ " (143 mm.) and $8\frac{3}{8}$ " (213 mm.). Eleven females average $6\frac{3}{8}$ " (162 mm.) and vary from $4\frac{13}{32}$ " (123 mm.) to $8\frac{9}{32}$ " (211 mm.). The proportions of an adult male from Riley County, Kansas, are as follows: total length $7\frac{1}{16}$ " (195 mm.), tail $3\frac{13}{32}$ " (87

mm.); head length $1\frac{1}{32}$ " (26 mm.), width $2\frac{5}{32}$ " (20 mm.). A female which is of the same length and which came from the same locality has a tail length of $3\frac{1}{8}$ " (80 mm.); head length $1\frac{3}{32}$ " (28 mm.), width $2\frac{5}{32}$ " (20 mm.).

HABITAT. During the dry season of the year the adults are seldom seen above the surface of the ground, but are occasionally dug out of burrows at a depth where the soil is at least slightly moist. During the first heavy rains of spring they often appear in large numbers and occupy the pools, ponds, "tanks," and slow streams for the breeding season. I have collected the larvae in temporary ponds, irrigation ditches, and backwaters of streams.

DESCRIPTION. The head is broad and somewhat convex above, widest at the angle of the jaws, the sides behind converging to the lateral extensions of the gular fold, in front abruptly to the broadly rounded and depressed snout. The eye is small, its horizontal diameter about 3 times in the snout; the iris brassy. An irregular slightly impressed line from the posterior angle of the eye to the lateral extension of the gular fold. Gular fold well developed. Trunk stout and with little indication of a median impressed line. Costal grooves usually 13, occasionally 12 or 14, counting 1 each in the axilla and groin, and the toes of the appressed limbs overlap 2 to 4 intercostal folds. The tail of the adult is rather long and slender, strongly compressed, rounded below and sharp-edged above. In the male it may comprise 42-50.7 per cent of the total length, and in the female 35-46.5 per cent, the higher percentages associated with the larger specimens. Legs large and stout. Toes 5-4, those of the hind feet 1-5-2-3-4 in order of length from the shortest; toes of the fore feet 1-4-2-3. Toes all webbed at base, rather long, flattened, tapering, and horny tipped. Plantar and palmar tubercles well developed. Tongue fleshy and broadly triangular, the narrow plicae parallel and extending to the margin from the broad posterior area. Vomerine teeth usually in a transverse, slightly arched series, which may be interrupted only at the mid-line or at this point and just inside the inner margin of each inner naris. Occasionally the teeth form a single series which arises just

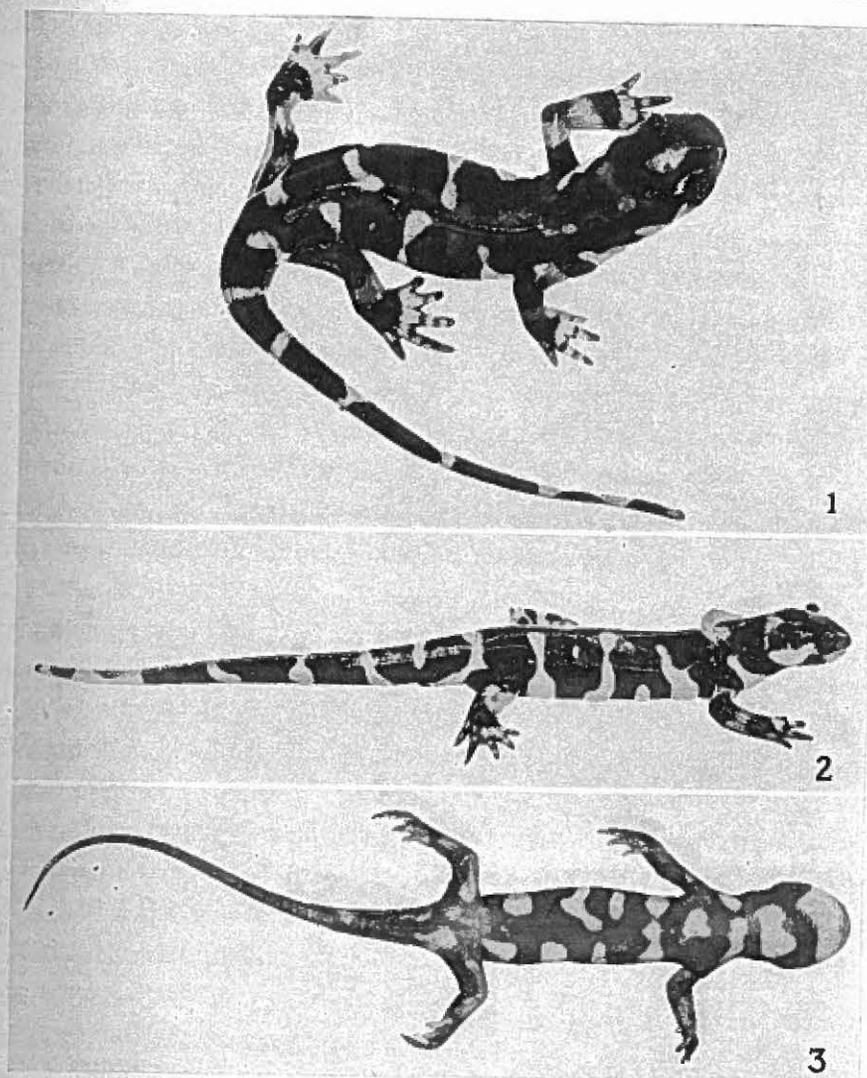


FIG. 44. *Ambystoma tigrinum mavortium* Baird. (1) Adult male, actual length $8\frac{1}{4}$ " (210 mm.). (2) Same, lateral view [from life]. (3) Same, ventral view [preserved specimen]. Winfield, Kansas.

outside and behind the outer margin of the inner naris and arches strongly forward between the nares.

COLOR. The general ground color is deep brown or black. The light

markings are developed in the form of irregular vertical bars or elongate blotches which vary in width and completeness but usually extend from the mid-line of the belly to the mid-line of the back. The light markings are sometimes confluent on the lower sides, forming a broad band between the legs and leaving the middle of the belly irregularly blotched with dark. Rarely the light markings unite at the mid-line of the back and more often cross the tail, giving it a ringed appearance. The light markings are yellow, varying in degree of intensity, but usually suffused with dusky on the back and clear yellow on the lower sides. The head and limbs are irregularly blotched.

BREEDING. In Lost Lake, Riley County, Kansas, Burt (1927, p. 2) found, on March 7, many eggs in cleavage stages attached singly or in small clusters to weed tops. Some eggs appeared to form a continuous series along the stem of a weed, and when removed to the laboratory began to hatch March 14.

LARVAE. The larvae attain a large size, to $8\frac{29}{32}$ " (226 mm.), sometimes exceeding the adults, and some are certainly neotenic. They are quite uniformly colored, in some waters light greenish, and acquire the barred pattern of the adults at the time of transformation. The axolotls have a very broad head, deep body, and broad fins. The dorsal fin arises on the back behind the head and attains its greatest width a short distance behind the vent. The ventral tail fin extends to the vent. The gills on some individuals are very long, the uppermost extending nearly to the hind legs. The legs are stout, the toes strongly depressed, broad at base, and sharply pointed.

CLOUDED TIGER SALAMANDER. *Ambystoma tigrinum nebulosum* Hallowell. Fig. 45. Map 20.

TYPE LOCALITY. San Francisco Mountains, Arizona.

RANGE. Interior Basin and Colorado Plateau in Utah, western Colorado, northwestern New Mexico, northern Arizona (Dunn, 1940, p. 158).

HABITAT. Adults and larvae are often found in the mountain lakes

and ponds and, occasionally, the adults on land, hiding beneath stones, logs, or bark. In the tanks and pools of ranches the axolotls are known as "water dogs." In the region of the type locality, San Francisco Mountains, Arizona, the salamander is said to be confined to the balsam-fir zone.

SIZE. The average length of 12 adults of both sexes from Utah and Boulder County, Colorado, is $7\frac{19}{32}$ " (192.25 mm.), the extremes $6\frac{3}{32}$ " (155 mm.) and $9\frac{1}{16}$ " (230 mm.). The males are a little larger than the females in the series I have measured, averaging $8\frac{1}{8}$ " (206 mm.), the females $6\frac{17}{32}$ " (166 mm.). The proportions of an adult male from Boulder County, Colorado, are as follows: total length $8\frac{3}{16}$ " (208 mm.), tail $3\frac{23}{32}$ " (95 mm.); head length $1\frac{1}{4}$ " (32 mm.), width $3\frac{1}{32}$ " (25 mm.). An adult female from the same locality measures: total length $6\frac{23}{32}$ " (171 mm.), tail $3\frac{1}{32}$ " (77 mm.); head length $3\frac{1}{32}$ " (25 mm.), width $2\frac{6}{32}$ " (21 mm.).

DESCRIPTION. The head is broad and convex above, the sides nearly parallel back of the eyes, in front evenly and broadly rounded to the tip of the snout. The eye is of moderate size, about $2\frac{1}{2}$ in the snout. An impressed line from the posterior angle of the eye to the lateral extension of the gular fold, a short vertical groove crossing this line at the angle of the mouth. Gular fold strongly developed. Trunk flattened ventrally, somewhat narrowed dorsally, and with an impressed median line. Tail flattened above at base, becoming strongly compressed immediately behind the vent, thin distally. There are usually 13 costal grooves, counting 1 in the axilla and 2 that run together in the groin, occasionally 12 or 14, and 2-4 intercostal folds are overlapped by the toes of the appressed limbs. Legs large and stout, toes 5-4, those of the hind feet broad at base, flattened and pointed, 1-5-2-3-4 in order of length from the shortest; toes of the fore feet 1-4-2-3. Palmar and plantar tubercles well developed, 2 on each foot. Tongue large and fleshy, free at the sides and behind only, the plicae narrow, parallel and extending to anterior margin; or, plicae broken into rows of small papillae. Vomerine teeth variable, sometimes forming a continuous

series which is strongly arched forward between the inner nares, commonly interrupted just inside the inner margin of the naris and again at the mid-line. When interrupted, 6-11 teeth in the outermost series and 12-20 in each of the inner series. During the breeding season the males have the cloacal glands greatly enlarged and the sides of the vent are swollen into 2 broad, rugose lobes, bluntly pointed behind. The vent of the female is much smaller, less protuberant, and has a narrow flange-like margin.

COLOR. The adults are olive-green or dark gray above, with a few small, scattered black spots on the back, sides, legs, and tail. The ventral surfaces are usually lighter than the dorsal and mottled and blotched with dark spots of irregular size and shape. There are from one to several dark spots on the throat, and often the blotches of the sides of the tail run together and form dark areas of considerable extent. Other races of the Tiger salamander have light spots above on a dark ground; *nebulosum* has black spots on a dark ground.

BREEDING. There is little known of the breeding habits of this subspecies and the only reference to the eggs I have found is a note by Dwight Franklin (Copeia, No. 21, 1915, p. 30). At an elevation of approximately 7000' at Flagstaff, Arizona, eggs were said to have been found in June. The salamander breeds in many of the streams, lakes, and ponds in the mountains; the larvae are often extremely abundant and are usually associated with a few transformed individuals.

LARVAE. In the high lakes of Colorado and other western states this species is often neotenic and reaches a size comparable to that of the transformed adults, the average length of 5 being $7\frac{7}{16}$ " (192 mm.). In life the larvae are rather uniformly olive-brown above, with small dark irregular spots on the back, sides, and tail. The belly is a little lighter and sometimes has a few small dark spots. The larvae have broad, convex heads and stout legs, with much flattened and pointed toes. The dorsal keel arises at the back of the head and reaches its greatest width a short distance behind the vent.

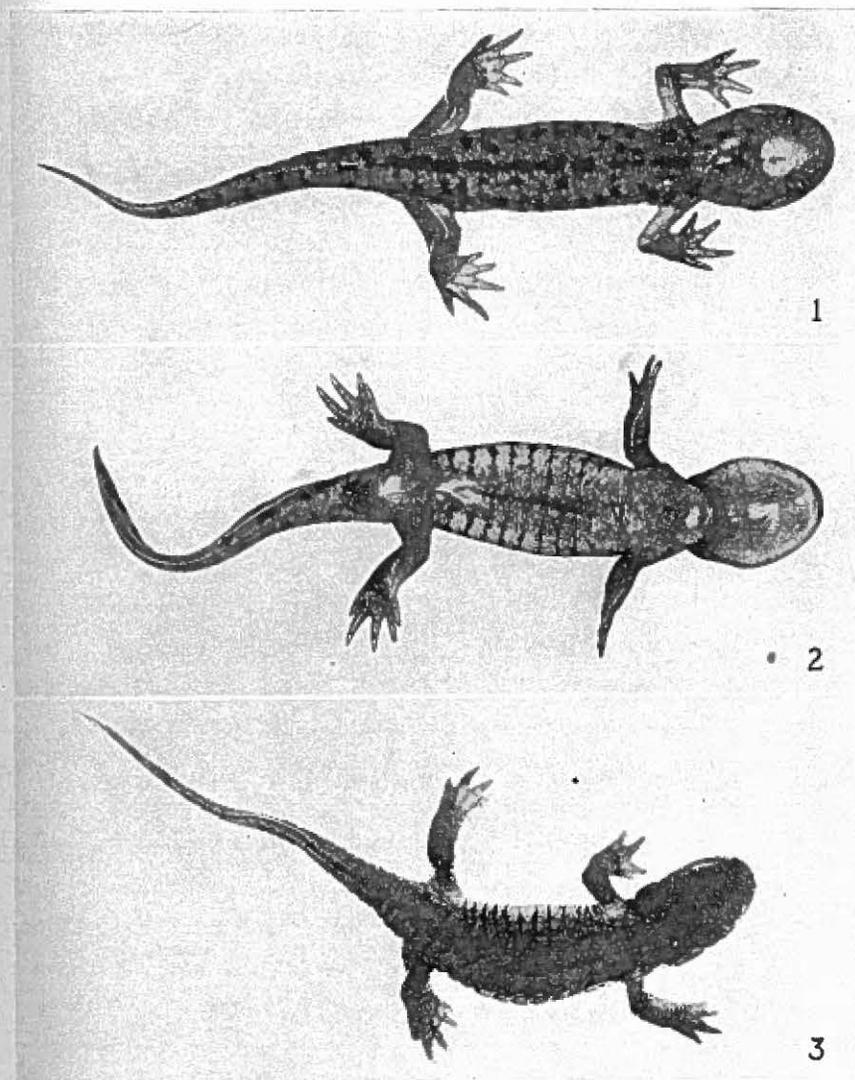


FIG. 45. *Ambystoma tigrinum nebulosum* Hallowell. (1) Recently transformed adult, actual length about $5\frac{1}{2}$ " (139 mm.). (2) Same, ventral view. Zion National Park, Utah. [A. H. Wright, collector.] (3) Old adult, female [preserved specimen]; actual length $6\frac{1}{2}$ " (165 mm.). Wasatch County, Utah.

NORTHWESTERN TIGER SALAMANDER. *Ambystoma tigrinum melanostictum* (Baird). Fig. 46. Map 20.

TYPE LOCALITY. Between Fort Union and Fort Benton, Montana.

RANGE. British Columbia, Alberta, Washington, Oregon, Idaho, Montana, Wyoming, North and South Dakota, Nebraska. (Dunn, 1940, p. 159.)

HABITAT. Adults are occasionally found in damp situations beneath logs, bark, boards, and stones. The larvae are sometimes extremely abundant in fresh-water ponds and lakes, where by day they are mainly in the deeper areas but at night come into the shallower waters along shore.

SIZE. The transformed adults reach an extreme length of about $8\frac{5}{8}$ " (219 mm.). Thirteen transformed individuals of both sexes from Washington average $5\frac{7}{16}$ " (139 mm.), the extremes $3\frac{3}{8}$ " (86 mm.) and $8\frac{3}{2}$ " (205 mm.). Six sexually mature adults in this series average $6\frac{19}{32}$ " (167 mm.). The proportions of a male from Lincoln County, Washington, follow: total length $6\frac{1}{2}$ " (165 mm.), tail $3\frac{1}{8}$ " (80 mm.); head length $1\frac{5}{16}$ " (24 mm.), width $1\frac{1}{16}$ " (18 mm.). A female from Medical Lake, Washington, measures: total length $5\frac{27}{32}$ " (150 mm.), tail $2\frac{7}{16}$ " (62 mm.); head length $1\frac{5}{16}$ " (24 mm.), width $1\frac{1}{16}$ " (18 mm.).

DESCRIPTION. The head is rather broad and short, widest at the angle of the jaws, the sides behind the eyes rounding to the lateral extensions of the gular fold, in front converging more abruptly to the bluntly rounded snout. Eyes moderate, the horizontal diameter about twice in the snout. An impressed line extends obliquely from the posterior angle of the eye to the gular fold and a short vertical groove from this line to the angle of the jaw. The trunk is well rounded and with an impressed median dorsal line. The usual number of costal grooves is 13, counting 1 in the axilla and 2 that run together in the groin; sometimes only 12, rarely 14, and the toes of the appressed limbs overlap 2-4 intercostal folds. The tail is flattened above at base and compressed shortly behind the vent, where it is rounded below and narrow above, and tapers

distally. A free dorsal keel is not well developed in the adults, but is evident in some recently transformed individuals, where it extends to a point a short distance behind the vent. The legs are large and stout, toes 5-4, those of the hind feet 1-5-2-4-3 in order of length from the shortest, the tips often pointed and horny, the bases slightly webbed; toes of the fore feet 1-4-2-3, slightly webbed at base. There are 2 plantar

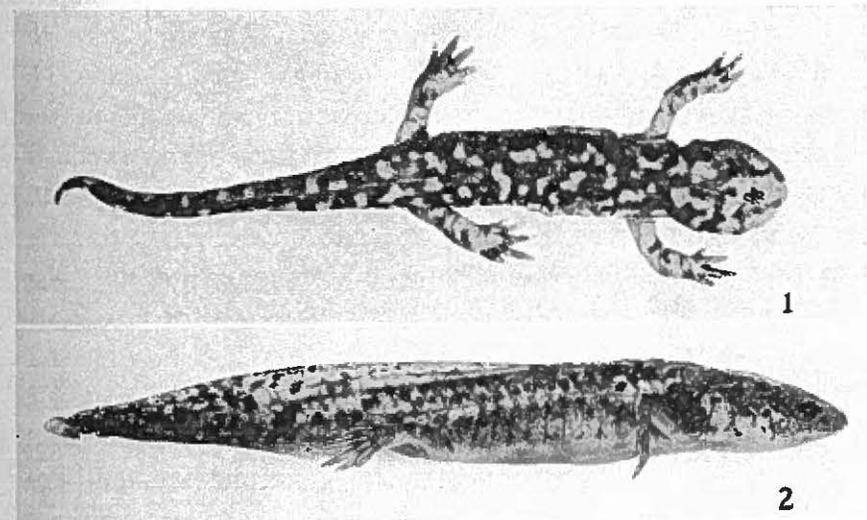


FIG. 46. *Ambystoma tigrinum melanostictum* (Baird). (1) Young adult, dorsal view; actual length $5\frac{7}{8}$ " (144 mm.). Medical Lake, Spokane County, Washington. [J. R. Slater, collector.] (2) Larva, lateral view; actual length $3\frac{1}{8}$ " (80 mm.). Near Crystal Creek, Wyoming. [Photographs of preserved specimens.]

and 2 palmar tubercles. The tongue is large, broadly oval in outline, free slightly at the sides, and provided with narrow parallel plicae. The vomerine teeth may be disposed in 3 series, but sometimes the middle one is narrowly interrupted at the mid-line. The lateral series of 6-10 teeth usually arise outside the outer margin of the inner naris and extend obliquely inward and forward to a point just inside the inner margin of the naris. A short break separates this series from the central one, which is usually strongly arched forward and may have 16-20 teeth on each limb.

COLOR. This subspecies is characterized by the extreme development of the light areas, which often form connected blotches of considerable size on the dorsal surfaces, so that the darker ground color persists in irregular patches. The light areas in life are dull yellow, the dark ground color brown to black, often darkest bordering the light areas. The upper surface of the legs is mottled and blotched, the sides of the tail with dark-bordered light areas sometimes forming more or less complete vertical bands. Recently transformed individuals sometimes have the light areas small and scattered over the dorsal and lateral surfaces. The throat, belly, and ventral surface of the legs may be light, with only a few darker blotches, or the light and dark blotches may be about equally distributed. The dark blotches on the sides of the tail extend to the ventral edge.

BREEDING. This form is known to be neotenic at times, Slater (1937, p. 82) having found eggs deposited by larvae taken April 5, 1935, and kept in captivity. These eggs were found to be like others taken in Medical Lake, Washington, April 6, 1934. Under natural conditions the eggs are deposited singly or in small clusters of 3-5 and attached to vegetation in shallow water near the margin of the lake. Individual eggs have a diameter of 1.9 mm. and are normally provided with three envelopes, the inner 2.6 mm. in diameter, the middle 3.5 mm., and the outermost 4.5 mm. when freshly deposited (Slater, 1937, p. 82).

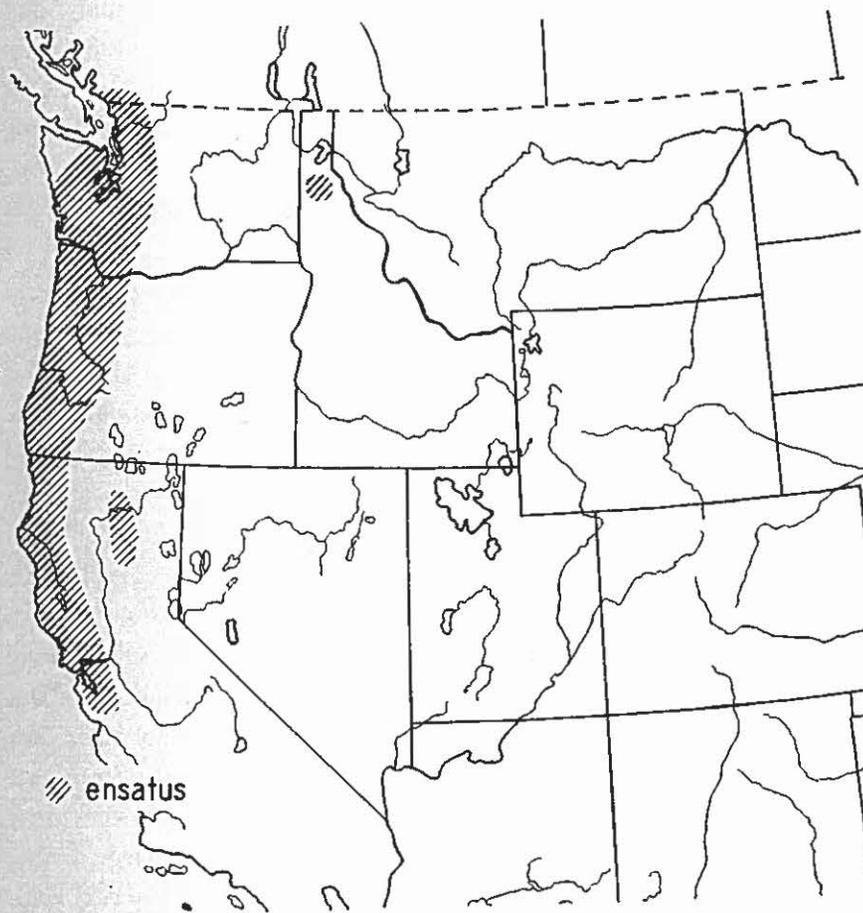
LARVAE. The larvae may transform at a length of only $3\frac{3}{8}$ " (86 mm.) or, as axolotls, attain a length of $10\frac{7}{8}$ " (276 mm.). Larvae only $2\frac{7}{16}$ " (62 mm.) long sometimes exhibit a color pattern suggestive of that of the adults. The light areas are extensive and the dark pigment is in the form of small irregular spots on the back and sides of the trunk, on the sides of the tail, and on the upper surface of the head and limbs. In Medical Lake, Washington, Slater found larvae transforming at the end of the summer.

GENUS DICAMPTODON

PACIFIC GIANT SALAMANDER. *Dicamptodon ensatus* (Eschscholtz). Figs. 29a, 47. Map 21.

TYPE LOCALITY. Vicinity of the Bay of San Francisco, California.

RANGE. Santa Cruz and Santa Clara Counties, California, northward through Oregon and Washington to southwestern British Columbia; northwestern Idaho and Rocky Mountains of Montana.



MAP 21.—Distribution of *Dicamptodon ensatus*. (Also recorded from the Rocky Mountains of Montana.)

HABITAT. This species is mainly limited to the humid coastal regions of the Northwest where there is abundant moisture throughout the year. On May 28, 1936, we collected adults of this species under logs and bark on the steep slopes of China Gulch at Gualala, California, and many larvae of various sizes in the stream below.

SIZE. This is the largest of the western species of salamanders, the transformed adults attaining an extreme length of nearly 12" (300 mm.). The measurements of an adult female from the south slope of Mt. Hood, Oregon, are as follows: total length $9\frac{5}{16}$ " (236 mm.), tail $3\frac{7}{8}$ " (98 mm.); head length $1\frac{5}{8}$ " (41.5 mm.), width $1\frac{1}{8}$ " (28 mm.). The smallest transformed individual I have measured is $5\frac{5}{16}$ " (135 mm.) from Gualala, California, and the largest larva, from Oak Grove, Clackamas County, Oregon, sent me by Mr. Stanley G. Jewett, $11\frac{1}{4}$ " (286 mm.). Storer (1925, p. 77) records a transformed individual only 122 mm. in total length.

DESCRIPTION. The body is stout, the limbs large and strong. The head is moderately broad, with the sides behind the eyes nearly parallel, in front tapering to the bluntly pointed and depressed snout. The mouth is large, the corner extending behind the eye a distance equal to the horizontal diameter of the eye. Eyes protuberant but of moderate size, iris deep brown, mottled with brassy. A horizontal impressed line from the posterior angle of the eye to the lateral extension of the gular fold. A short vertical line from the angle of the jaw to the horizontal groove. The trunk is well rounded above. Costal grooves 12, counting 1 each in axilla and groin, poorly defined. Tail thick and nearly subquadrate in section at base, tapering rapidly and becoming wedge-shaped at about $\frac{1}{2}$ its length, the upper edge thinnest but without a definite keel. Toes 5-4, those of the hind feet 1-5-2-3-4 in order of length; front feet 1-4-2-3. Soles of the feet in recently transformed individuals sometimes with indistinct tubercles, in large adults smooth. Tongue large, fleshy, free along margins, plicae slightly diverging from the posterior field. Vomerine teeth behind inner nares and forming a transverse series which is narrowly interrupted where it bends forward at the mid-line,

Literally the teeth extend nearly to the outer margin of the inner naris.
COLOR. The ground color and markings vary considerably in intensity.

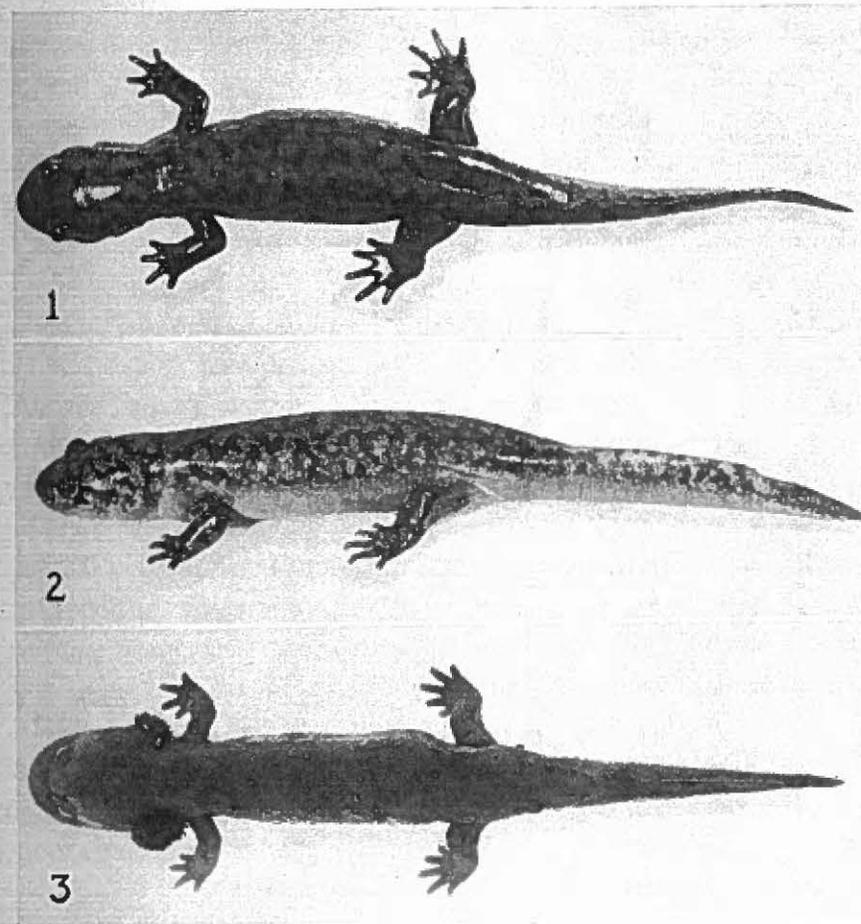


FIG. 47. *Dicamptodon ensatus* (Eschscholtz). (1) Adult male, actual length $9\frac{1}{16}$ " (245 mm.). (2) Same, lateral view. Sandy, Oregon. (3) Larva, actual length $11\frac{1}{8}$ " (286 mm.). Oak Grove, Clackamas County, Oregon.

In life a large female had the ground color above comparatively light (Dresden Brown, Ridgway), mottled and marbled with deep brown (Warm Sepia, Ridgway), fading to chocolate on the sides. The darker markings involve the entire dorsal and lateral surfaces of the head and

encroach narrowly on the ventral surfaces of the lower jaws. On the sides of the trunk, the darker markings anteriorly extend to the level of the front legs, posteriorly the line of demarcation curves above the insertion of the hind legs and continues along the ventrolateral margins of the tail. The legs above are colored like the back. The ventral surfaces are lighter than the ground color of the lower sides; in the region of the throat, vent, and lower ridge of the tail, dull flesh color. In some individuals the mottlings may be very dark, almost black, and in strong contrast with the lighter ground color.

BREEDING. Eggs apparently of this species were reported by Henry and Twitty (1940, p. 247), attached singly to the surface of a timber in rapidly running water in San Mateo County, California, found June 19, 1937. The lot consisted of about 70 albino embryos in the "tail-bud" stage of development.

LARVAE. Larvae are characterized by the restriction of the dorsal fin to the tail, the absence of balancers, and the simultaneous development of the fore and hind limbs. In larvae nearing transformation the general ground color is Fuscous (Ridgway). Scattered over the dorsal surface of the body and limbs are aggregates of small, rounded, tan spots which form blotches of varying size. The lower sides are tinged with bluish-gray and the ventral surfaces light gray with tinges of flesh in the region of the vent. Gills short, bushy, and dull red. In larvae of all sizes the dorsal fin is never continued anteriorly beyond the insertion of the hind legs, and in large larvae often extends forward only to the posterior end of the vent.

GENUS RHYACOTRITON

OLYMPIC SALAMANDER. *Rhyacotriton olympicus* (Gaige). Figs. 29b, 48.

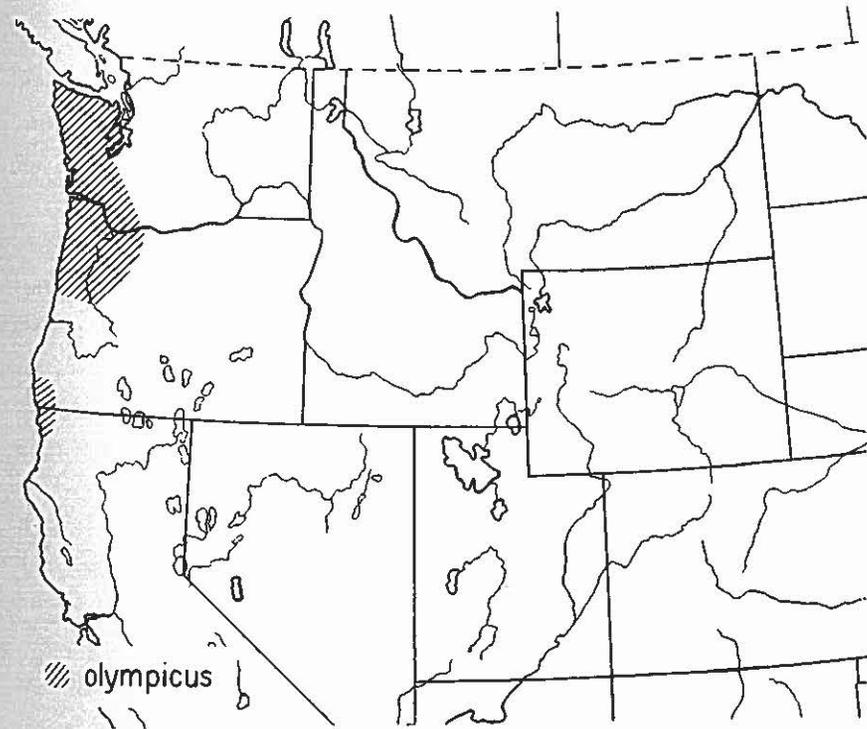
Map 22.

TYPE LOCALITY. Lake Cushman, Washington.

RANGE. From Rouge River Basin, Curry County and Clackamas County, Oregon, throughout western Washington.

HABITAT. On June 21, 1936, we collected along the Calawah River,

½-mile north of Forks, Washington, where springs flowed from beneath overhanging banks covered by tangles of thick vegetation. Here, among stones and gravel washed clean by the water, we found a fine series of specimens in company with *Plethodon vandykei*, *P. vehiculum*



MAP 22.—Distribution of *Rhyacotriton olympicus*.

and *Ascaphus truei*. On June 20 we collected this species by the side of a small trickle on a steeply wooded slope near Shelton, Washington. Slater (1934, p. 140) reported this species in and near small streams which drain into Spirit Lake.

SIZE. The average length of 5 adult males is 3½" (88.6 mm.); 5 adult females average 3¹⁵/₂" (87.8 mm.). The largest male, from ½ mile west of Forks, Washington, has a total length of 4¹/₁₆" (103 mm.), tail 1¹/₁₆" (42 mm.); head length ½" (12 mm.), width 3/8" (9 mm.). A female of

exactly the same length from 7 mi. west of Shelton, Washington, has the tail $1\frac{19}{32}$ " (40 mm.); head length $1\frac{17}{32}$ " (13 mm.), width $\frac{3}{8}$ " (9 mm.).

DESCRIPTION. This species is characterized by the short, wide head, very prominent eyes, and short tail. The head is widest at the eyes, tapering abruptly to the short, blunt snout, and with the sides back of the eyes straight and nearly parallel or slightly converging. The eyes are large and bulging, their horizontal diameter equal to or greater than the distance from the anterior angle of the eye to the end of the snout. The gular fold is strongly developed and has prominent lateral extensions. There is a deep decurved groove extending from the posterior angle of the eye to join the lateral extensions of the gular fold; a short groove from this to the angle of the mouth. The trunk is moderately stout, rounded on the sides, flattened beneath, and with an impressed median dorsal line. There are 14 costal grooves, counting 1 each in the axilla and groin, and 2-3 intercostal spaces between the toes of the appressed limbs. The tail is oval in section at the base, flattened or rounded below, compressed above, flattened distally, and produced into a blunt point. The legs are short and stout, toes 5-4, webbed at base, those of the hind feet 1-5-2-3-4 in order of length from the shortest; toes of the fore feet 1-4-2-3. Tongue moderate, longer than wide, the sides only free and narrowly depressed and smooth; the deep, narrow plicae diverge slightly from the posterior field. The vomerine teeth are in 2 strongly arched series narrowly separated at the mid-line. In the female, the series arise behind the middle of the inner naris and consist of about 11 teeth; in the male, the series arise nearer the outer margin of the inner naris, the teeth number 8-9 and are larger, longer, and more prominently hooked at tip.

COLOR. The ground color above is a rich seal-brown, variegated with fine white specks which become more numerous and somewhat larger on the sides. The upper surface of the tail is distinctly lighter brown, and there is a conspicuous depressed line on the back between the hind legs. The belly is bright yellow, nearly orange in some, except in the region below the liver, where there is a greenish tinge. The throat is

marked with irregular grayish-white flecks and mottled and blotched with larger, light brown spots. The entire ventral surface is sparsely flecked with small whitish points and often with a few irregular brown spots. The dark dorsal coloration extends on the sides of the head to involve the upper jaw, and covers the upper surface of the limbs, the

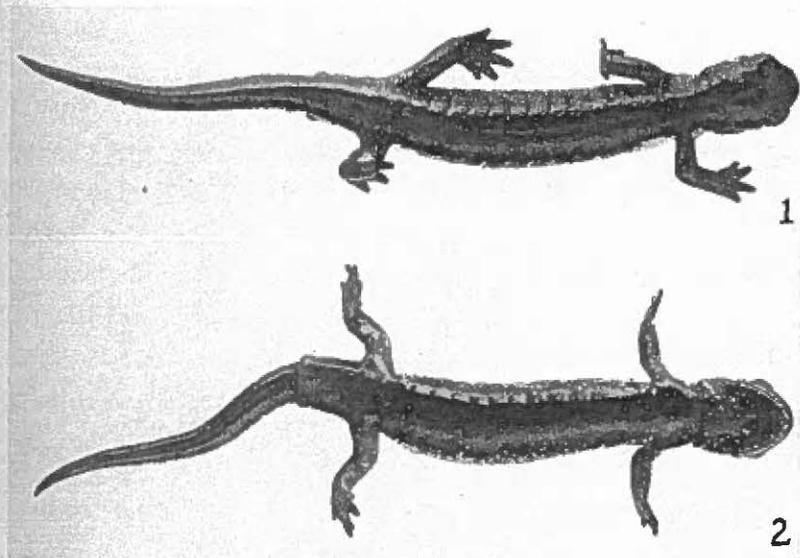


FIG. 48. *Rhyacotriton olympicus* (Gaige). (1) Adult male, actual length $3\frac{11}{16}$ " (93 mm.). (2) Same, ventral view. Calawah River, Forks, Washington.

sides of the trunk to the sides of the belly, and the sides of the tail nearly to the ventral surface. The lower surface of the legs is yellow. Slater (1938, p. 136) mentions specimens from near Sandy, Oregon, which, in life, were light brown with small black spots on their lateral and dorsal surfaces and cream-colored below.

SEXUAL DIFFERENCES. The sexes may be distinguished by the form of the vent. In the male the sides of the vent are produced into squarish lobes behind, the outer angles light-tipped and visible from above.

BREEDING. Mr. Phillips G. Putnam, in the Olympic Mountains, Washington, discovered single salamander eggs during June under circum-

stances which led to the belief that they belonged to this species (Noble and Richards, 1932, p. 19). The eggs were attached to the lower surface of a stone in running water. Noble and Richards (*ibid.*, p. 20), employing the pituitary technique, subsequently induced a number of females to deposit eggs in the laboratory. The individual egg is large and without pigment, the yolk having an average diameter of 4.5 mm., without the 3 envelopes which surround it. Few eggs are deposited, the average being about 5.

LARVAE. The larvae may attain a length of 69 mm. before transformation (Slater, 1938, p. 136), but the usual size is considerably smaller. I have a single specimen with greatly reduced gills only 31 mm. long. The tail is narrowly keeled above, but the keel of the back is lacking as in *Dicamptodon ensatus*.

Family PLETHODONTIDAE

Aquatic and terrestrial; size small to medium, $1\frac{9}{16}$ " (40 mm.) to $8\frac{5}{8}$ " (219 mm.); lungs absent; a nasolabial groove; adults usually without gills, a few neotenic species; toes 5-4 or 4-4; vomerine and palatine teeth usually present; ypsiloid cartilage reduced or lacking; tongue free all around or attached anteriorly.

KEY TO THE GENERA OF PLETHODONTIDAE

1. Toes 4-4 2
Toes 5-4 5
2. Tail with a basal constriction; belly white with black flecks; size small, to $3\frac{1}{2}$ " (89 mm.). Eastern states, southern Canada southward through Michigan to Gulf; only the single species *Hemidactylium scutatum* p. 306
Tail without a basal constriction; belly not white with black specks ... 3
3. Tail compressed and slightly keeled above; a median dorsal band limited either side by a dark line; belly yellow; size small, to $3\frac{5}{16}$ " (84 mm.). Southeastern states; only the single species *Manculus quadridigitatus* p. 446
Tail not compressed and keeled above, nearly circular in section ... 4
4. Body and tail elongate and worm-like; vomerine teeth in short series or patches widely separated from parasphenoids; costal grooves 17-21; belly not black with white spots; size to $6\frac{3}{4}$ " (172 mm.). Pacific Coast states and adjacent islands BATRACHOSEPS p. 310
Body and tail not exceptionally elongate and worm-like; vomerine series longer, 10-15, continuous with or narrowly separated from parasphenoids; above with a chestnut or reddish-brown band; belly black with white flecks; size to $3\frac{13}{16}$ " (97 mm.). Oregon; only the single species *Plethopsis wrighti* p. 290
5. Tail with a basal constriction; palm with two tubercles; length to $5\frac{1}{8}$ "

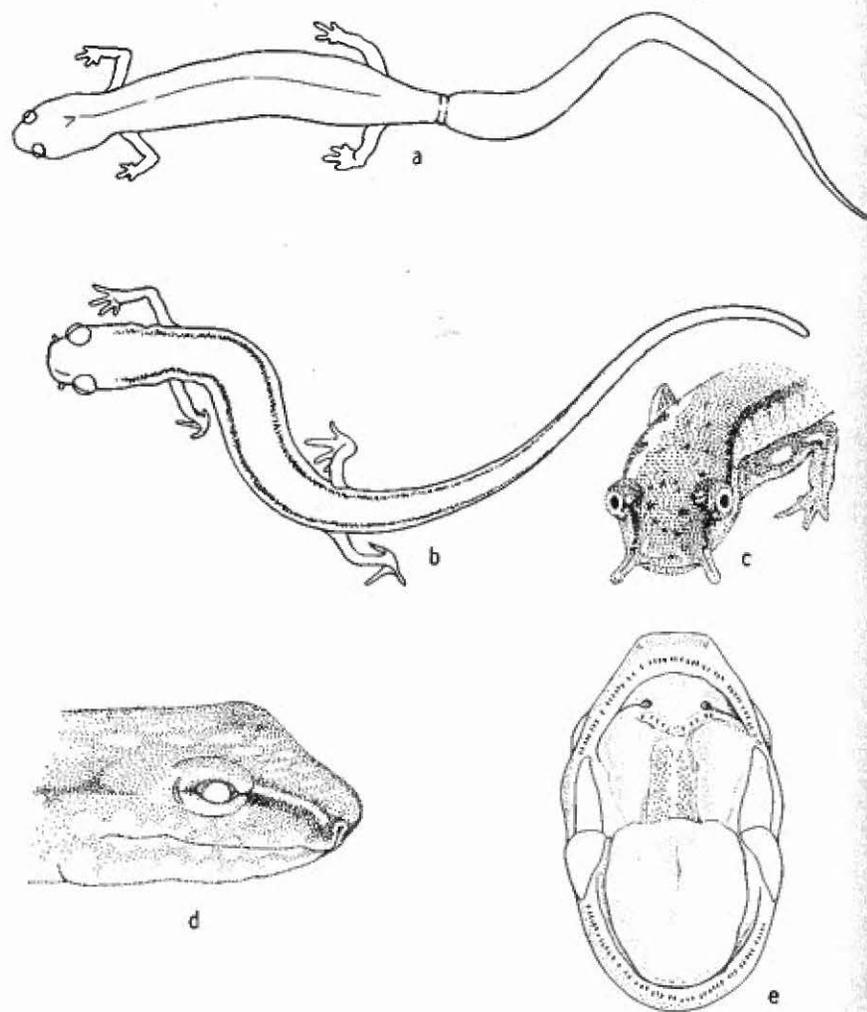


FIG. 49. (a) Outline of *Hemidactylum scutatatum* to show the basal constriction of the tail and the four toes on both fore and hind feet. (b) Outline of *Eurycea bislineata cirrigera*, adult male, to show the cirri. (c) Same, head enlarged, front view. The nasolabial grooves extend along the cirri nearly to the tip. (d) Head of *Gyrinophilus* to show the canthus rostralis and the nasolabial grooves. (e) Mouth parts of *Plethodon jordani* to show the character of tongue and teeth. [a-d, H.P.C. del.; e, M.L.S. del.]

- (150 mm.). Pacific Coast, southwestern California to British Columbia and Vancouver Island *ENSATINA* p. 293
- Tail without a basal constriction; no palmar tubercles 6
6. Tongue with a central pedicel, free all around 7
- Tongue free at sides and behind only 10
7. Vomerine and parasphenoid teeth forming continuous series 8
- Vomerine and parasphenoid teeth not in continuous series 9
8. Canthus rostralis marked by a light bar bordered above and/or below with black; dorsal pattern sometimes with dark flecks but without separate rounded black spots; size to $8\frac{5}{8}$ " (219 mm.). Ontario, Canada southward through the eastern states to Georgia and Alabama *GYRINOPHILUS* p. 360
- No marked canthus rostralis bordered above and below by black; color above bright red to purplish or chocolate-brown, marked with black spots; size to 7" (178 mm.). Eastern states, New York to Florida and the Gulf of Mexico *PSEUDOTRITON* p. 376
9. Toes strongly webbed; above dark brown to black, marked with light flecks sometimes aggregated in lichen-like patches; costal grooves 13; tail short, nearly circular in section; size to $4\frac{3}{32}$ " (104 mm.). High Sierras in California; only the single species *Hydromantes platycephalus* p. 451
- Toes not webbed, or at most only slightly at base; tail moderate to long, compressed; ground color usually some shade of yellow or orange; size to $7\frac{5}{32}$ " (182 mm.). New Brunswick and Quebec southward through the eastern states to Georgia, westward to New Mexico, northward through Texas, Oklahoma, and Kansas to southern Illinois *EURYCEA* p. 402
10. Eyes normal; body well pigmented 11
- Eyes reduced, partly or completely hidden by fused lids, or eyes lacking; body with little or no dark pigment 15
11. Posterior part of maxilla sharp-edged and without teeth; vomerine teeth present, usually 5-9; size to $6\frac{3}{8}$ " (162 mm.). Cumberland Plateau in the east; British Columbia to Lower California *ANEIDES* p. 327
- Posterior part of maxilla with teeth; vomerine teeth often lacking in adult males 12
12. Opening of inner nares conspicuous 13
- Opening of inner nares hidden in a fold at sides of mouth; vomerine teeth usually lacking in adult males, sometimes present but reduced in number in females; length to $5\frac{1}{16}$ " (128 mm.). Western North Carolina *LEUROGNATHUS* p. 220
13. Sensory pits on head conspicuous; vomerine and parasphenoid series continuous; alternating light and dark longitudinal lines on sides; length to $3\frac{3}{4}$ " (95 mm.). From Dismal Swamp, Virginia, to Liberty County, Georgia, in the Coastal Plain; only the single species *Stereochilus marginatus* p. 346

- No conspicuous sensory pits on head; vomerine and parasphenoid series not continuous; no alternating dark and light longitudinal lines on sides 14
14. Tail trigonal or circular in section; a light bar from posterior angle of eye to angle of the jaw; body rather short and stout. *DESMOGNATHUS* p. 186
Tail always circular in section or nearly so; no light bar from eye to angle of the jaw; body usually long and slender *PLETHODON* p. 228
15. Adults fully transformed, without gills; white or very lightly pigmented; eyes with lids partly or completely fused; legs normal; length to 5 $\frac{1}{16}$ " (135 mm.). Ozark Plateau in Missouri, Oklahoma, Kansas, and Arkansas; only the single species *Typhlotriton spelæus* p. 351
Adults not fully transformed, with gills; pigment lacking; eyes lacking 16
16. Costal grooves 11; vomerine and palatine teeth in continuous series; snout wide but not greatly depressed; sides of head nearly parallel; length 3" (75.5 mm.). Known only from a well at Albany, Georgia *Haideotriton wallacei* p. 355
Costal grooves 12; vomero-palatine teeth not forming a continuous series; snout narrower than head back of eyes and strongly depressed; length to 5 $\frac{3}{16}$ " (136 mm.). Eastern central Texas in wells and underground streams; only the single species . . . *Typhlomolge rathbuni* p. 357

GENUS DESMOGNATHUS

KEY TO THE SPECIES AND SUBSPECIES OF DESMOGNATHUS

1. Tail trigonal in section and often keeled above 2
Tail oval or nearly circular in section and not keeled above 8
2. Snout and head to back of eyes, distal half of tail and legs white or very lightly pigmented; back deep brown, belly light brown; 14 costal grooves; one intercostal fold between toes of appressed limbs; length to 3 $\frac{1}{2}$ " (91 mm.). Known only from Demorest, Georgia *quadramaculatus amphileucus* p. 214
Snout and head, tail and legs not white or very light 3
3. Belly dark 4
Belly light 5
4. Belly uniformly pigmented, deep brown to blue-black; back and sides in old individuals black, sometimes with small rusty blotches; back of head and snout often rusty; juveniles with a row of small light spots dorsolaterally and a second row at juncture of lower sides and belly; vomerine teeth present in adults of both sexes, 5-12; light line from eye to angle of jaw often indistinct; usually 14 costal grooves and 2-3 intercostal folds between toes of appressed limbs; length to 6 $\frac{7}{8}$ " (175 mm.). West Virginia and Virginia southward in the mountains to northern Georgia . . . *quadramaculatus quadramaculatus* p. 210

- Belly strongly mottled, deep brown and white; back dark brown (almost black); lower sides bluish-gray to grayish-brown; dorsal surface of tail basally often with a russet band with irregular edges; often with a dorsolateral row of small light dots and a second row on lower sides between the legs and on basal half of tail; light mark on side of head from eye to angle of jaw narrow to broad and bright orange-red to russet; length to 4 $\frac{19}{32}$ " (118 mm.). Virginia south to central Florida, west to Louisiana *fuscus auriculatus* p. 193
5. Belly uniformly but lightly pigmented 6
Belly light but mottled 7
6. Back without a longitudinal band or conspicuous markings, or, if band is present, then poorly defined and limited each side by faint light spots; usually a row of small light dots on sides above the legs and sometimes a second row at juncture of lower sides and belly; vomerine teeth lacking in adult males; usually 14 costal grooves and 3-5 intercostal folds between toes of appressed limbs; length to 5 $\frac{1}{4}$ " (134 mm.). Northeastern Texas, Oklahoma, and Arkansas *fuscus brimleyorum* p. 196
Back with conspicuous light spots or blotches heavily outlined with dark brown or black, or, back with heavy light and dark worm-like markings; lower sides usually mottled and sometimes with a row of light dots on sides between the legs; 13 costal grooves, occasionally 14, and 4-5 intercostal folds between toes of appressed limbs; vomerine teeth present in adults of both sexes; length to 5 $\frac{1}{8}$ " (131 mm.). Southwest Pennsylvania southward through Virginia and West Virginia to Georgia and Tennessee in the mountains *phoca* p. 206
7. Back yellowish-brown to nearly black, often without a dorsal band; if dorsal band present then with irregular edges or limited either side by dark-edged semicircular or worm-like markings; sides usually without a series of small light dots; usually 14 costal grooves and about 4 intercostal folds between toes of appressed limbs; length to 4 $\frac{3}{32}$ " (121 mm.) in North, to 5 $\frac{7}{8}$ " (149 mm.) in Harlan County, Kentucky. New Brunswick to northwestern Georgia, west to Mississippi, northward to Illinois *fuscus fuscus* p. 188
Back deep brown to black, without a band but sometimes with a dorsolateral series of light, dark-bordered spots extending onto the tail; light bar from eye to angle of jaw conspicuous, reddish or yellowish; other characters as above under 4 *fuscus auriculatus* p. 193
8. Median dorsal light stripe with straight edges, belly light; or, if uniformly black above, then belly dark; sides mottled; vomerine teeth lacking in adult male; length to 3 $\frac{3}{4}$ " (96 mm.). New York southward to Virginia and West Virginia, west to Kentucky and northward to Ohio *ochrophæus ochrophæus* p. 199
Median dorsal light stripe with irregular edges 9
9. Size to 4 $\frac{1}{32}$ " (113 mm.); dorsal light band variable in color but when

present always with irregular edges; belly lightly mottled; or, if uniformly black above, then belly also darker; upper sides usually dark; vomerine teeth lacking in adult males. Virginia and West Virginia south to Georgia in the mountains *ochrophæus carolinensis* p. 203

Size small, to 2" (51 mm.); dorsal light band light-tan to reddish, often bronzy; many individuals with a definite herringbone pattern along the mid-line of back; light line from eye to angle of jaw often conspicuous; belly light; vomerine teeth 3-7, present in adults of both sexes; tail short, 34-43 per cent of the total length. High elevations in the mountains of North Carolina, Tennessee, and western Virginia *wrightii* p. 216

NORTHERN DUSKY SALAMANDER. *Desmognathus fuscus fuscus* (Rafinesque). Figs. 50b, 51, 101b. Map 23.

TYPE LOCALITY. Northern parts of the State of New York.

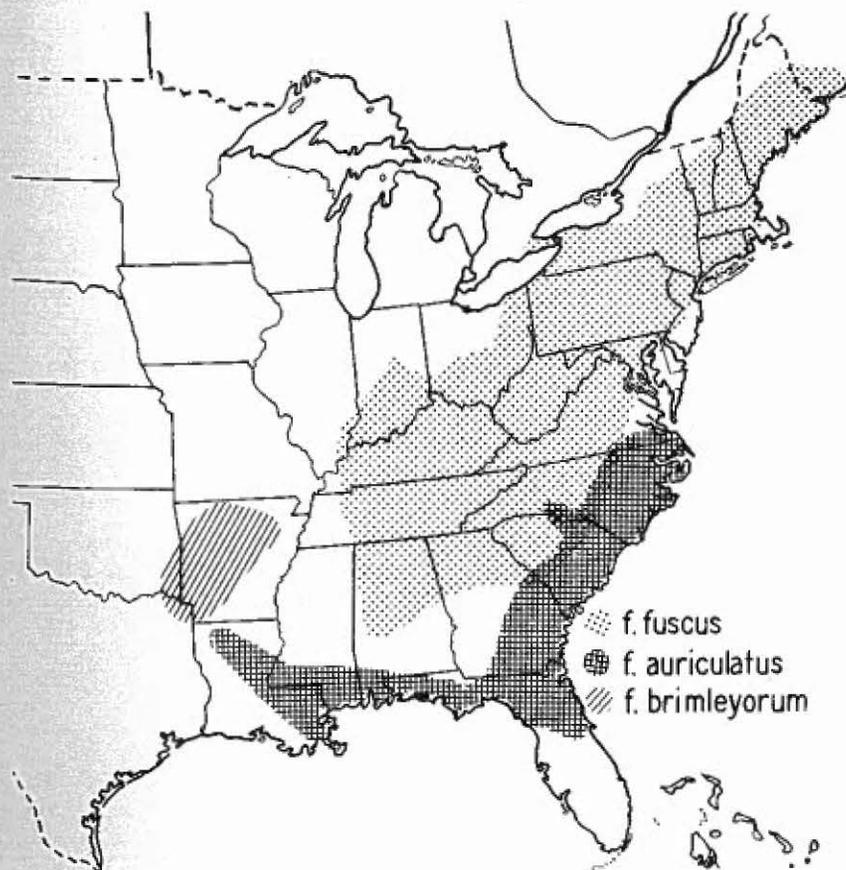
RANGE. St. John's River, New Brunswick, to northern Georgia and Alabama, northward to Illinois, Indiana, Ohio, and Ontario opposite Buffalo, New York.

HABITAT. Frequents the margins of streams and springs, leaf-filled trickles, springy banks where the soil is constantly moist, and often the beds of partially dry streams in deep ravines. Occasionally enters the water but is essentially terrestrial.

SIZE. Ninety adult males from near Rochester, New York, average $3\frac{19}{32}$ " (91.2 mm.), with extremes of $2\frac{9}{16}$ " (65 mm.) and $4\frac{13}{32}$ " (113 mm.); 65 adult females average $3\frac{7}{32}$ " (82.5 mm.), the extremes $2\frac{19}{32}$ " (66 mm.) and $3\frac{29}{32}$ " (100 mm.). In this vicinity the males reach an extreme length of $4\frac{23}{32}$ " (121 mm.). The proportions of an adult male are as follows: total length $4\frac{11}{32}$ " (111 mm.), tail 2" (51 mm.); head length $\frac{19}{32}$ " (15 mm.), width $\frac{3}{8}$ " (10 mm.). An adult female measures: total length 4" (102 mm.), tail $1\frac{7}{8}$ " (48 mm.); head length $\frac{1}{2}$ " (13 mm.), width $\frac{5}{16}$ " (8 mm.).

DESCRIPTION. This is an extremely variable species in color and pattern, and strongly aberrant individuals may be found in almost any locality. In the adult male the head is somewhat swollen between the angle of the jaw and the lateral extension of the gular fold and is widest posteriorly; from the angles of the jaw the sides curve evenly to the bluntly

pointed snout. The eyes moderately large and protuberant and limited behind by vertical groove, the iris flecked with brassy, and with a narrow line of gold bordering the pupil. An impressed line from the posterior



MAP 23.—Distribution of the subspecies of *Desmognathus fuscus*.

angle of the eye to the lateral extension of the gular fold; a short vertical groove from this line to the angle of the jaw. The trunk is well rounded above and on the sides and with an impressed median line above. There are usually 14 costal grooves, with 1 in the axilla sometimes forked above, and $4\frac{1}{2}$ intercostal folds between the toes of the appressed limbs. The tail is subquadrate in section at base, trigonal in section beyond the

base, and becoming knife-edged above and slender toward the tip. The legs are relatively short and stout, the hind noticeably larger than the fore. Toes 5-4, those of the hind feet 1-2-5-4-3 in order of length from

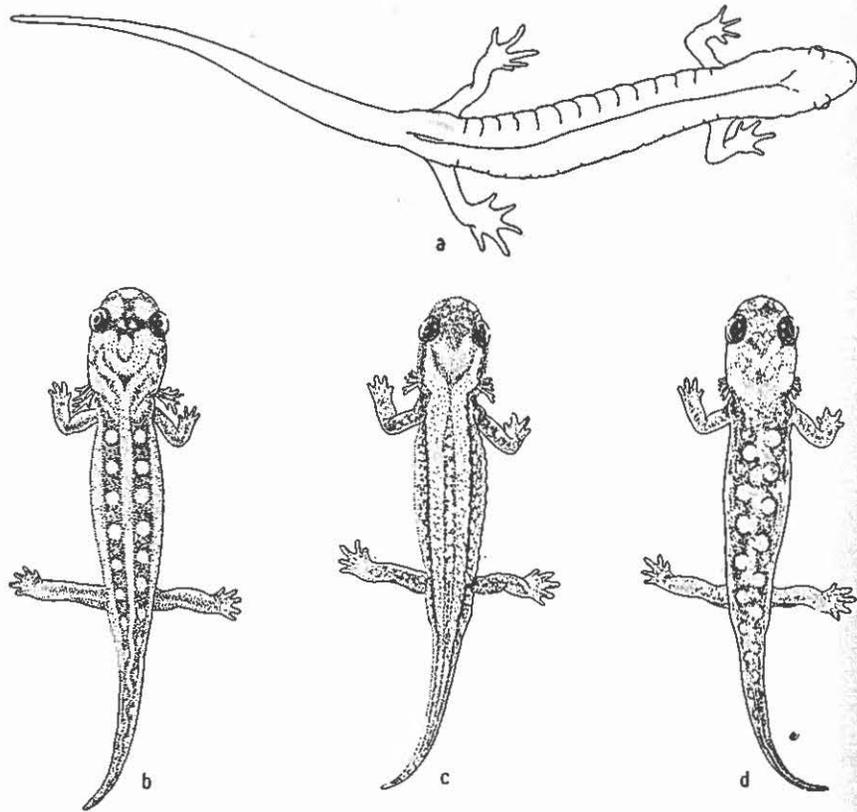


FIG. 50. (a) Outline of *Desmognathus ochrophaeus carolinensis* to show the form of the body, legs, feet, and tail. (b) Recently hatched larva of *Desmognathus fuscus fuscus*. (c) Recently hatched larva of *Desmognathus ochrophaeus ochrophaeus*. (d) Recently hatched larva of *Desmognathus o. carolinensis*. [H. P. Chrisp, del.]

the shortest; toes of the fore feet 1-4-2-3. Tongue small, broadly oval in outline, free at the sides and back, the surface marked with narrow plicae which radiate from the posterior field. Vomerine teeth usually lacking in the adult male; in the female small, in short series of 5-7

which arise behind the inner margin of the inner naris and curve inward and backward toward the mid-line, where they are separated by about

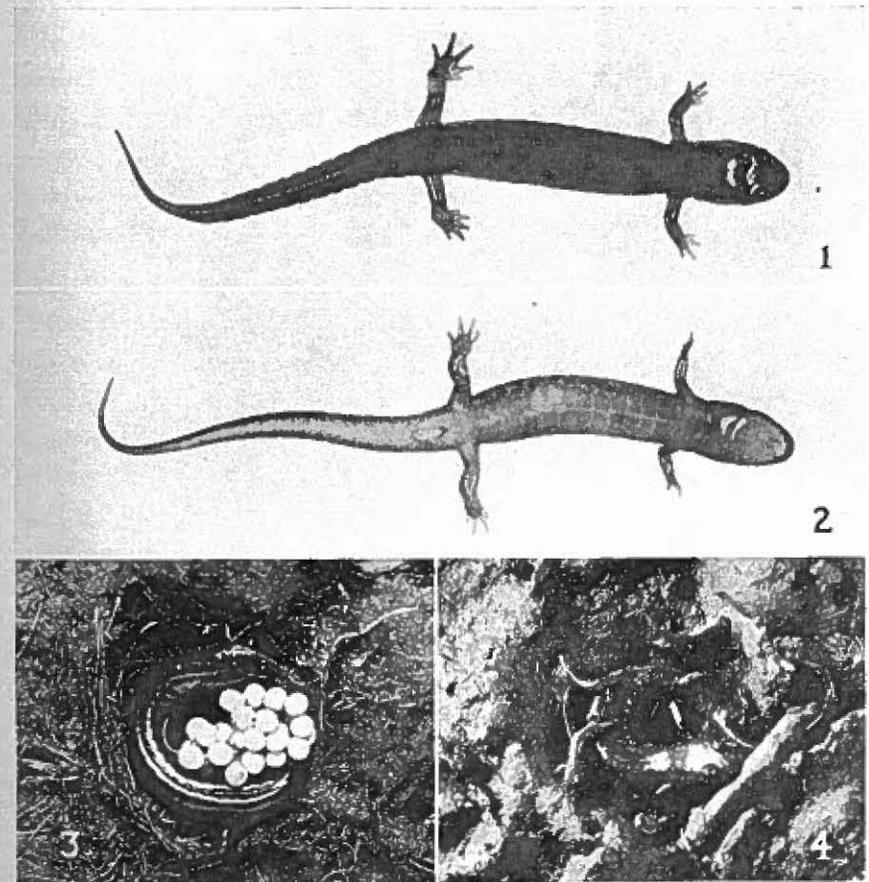


FIG. 51. *Desmognathus fuscus fuscus* (Rafinesque). (1) Adult male, actual length $3\frac{1}{16}$ " (84 mm.). (2) Same, ventral view. Allegany State Park, New York. (3) Female with eggs. Stamford, New York. (4) Female with young. Cornwall, Connecticut.

$\frac{1}{2}$ the diameter of a naris. Parasphenoid teeth in elongate patches which may be narrowly separated or united anteriorly and slightly divergent behind; widely separated from the vomerine teeth in the female.

COLOR. There is much variation in the intensity of pigmentation and

in degree of development of the dorsal pattern. The ground color above varies from light yellowish-brown to deep brown and black. Typically there is a broad median band above with irregular dark edges, but the band is often obscured in the dark ground color. When present it is lighter than the adjacent sides, which are dark brown to black, fading gradually to the level of the legs and there becoming lighter and lightly mottled. Frequently the dorsal band is best developed on the posterior part of the trunk and basal part of the tail, where it is often invaded with darker worm-like markings enclosing lighter spots. The throat, belly, and lower surface of the limbs and tail are light flesh color in life, tinged with bluish, and varied by small pigment-free spots. A small, light bar extends from the posterior angle of the eye to the angle of the jaw. In the male the head is larger than in the female and has the sides swollen; the tip of the lower jaw is somewhat pointed and bears a small mental gland, and the vent is lined with papillae.

BREEDING. The breeding habits have been made known by Wilder (1913, 1923), Noble and Brady (1930), and others. In courtship the male applies the snout, cheeks, and mental gland to the snout of the female, who usually responds by picking up a spermatophore. The eggs are deposited in small, compact clusters of 12-26 (average 17), and cling to one another by extensions of the outer envelope. The eggs are found in June, July, and August, and are attended by the female in her nest beneath logs, stones, or bark, in the vicinity of water. Individual eggs are about 3 mm. in diameter and have 3 envelopes, the 1st of clear jelly and fairly thick, the 2nd thin, and the outer thin, tough, and elastic, and with a total diameter of about $4\frac{1}{2}$ mm.

LARVAE. Larvae at hatching average about 16 mm. and are gray above in a broad band which extends from the head onto the basal half of the tail. Within the dorsal band, and separated by a median light stripe, are 7-9 pairs of round light spots. The sides of the trunk and legs above are lightly but distinctly mottled. Larvae may attain a length of 44 mm. and transform at an age of 7-9 months. Larval gills are slender and glistening white.

SOUTHERN DUSKY SALAMANDER. *Desmognathus fuscus auriculatus* (Holbrook). Fig. 52. Map 23.

TYPE LOCALITY. Riceborough, Georgia.

RANGE. Dismal Swamp, Virginia, south to central Florida, west to Louisiana in the Coastal Plain.

HABITAT. Found under logs, bark, and other surface debris, in or beside swamp streams and springs. Typical specimens were found in numbers in the bottom lands of the Tickfaw River near Greensburg, Louisiana, March 19, 1936, where they were hiding beneath logs and bark in damp situations.

SIZE. The average length of 13 adults of both sexes from Georgia and Florida is $3\frac{2}{32}$ " (95 mm.). Five adult males average $3\frac{2}{32}$ " (100 mm.) and vary from $3\frac{2}{32}$ " (93 mm.) to $4\frac{3}{16}$ " (107 mm.). Five adult females average $3\frac{1}{2}$ " (89 mm.), the extremes $3\frac{1}{32}$ " (85 mm.) and $3\frac{1}{16}$ " (94 mm.). The males reach an extreme length of about $4\frac{1}{32}$ " (118 mm.). The proportions of an adult male from the type locality, Riceborough, Georgia, are as follows: total length $4\frac{5}{16}$ " (110 mm.), tail $2\frac{3}{16}$ " (56 mm.); head length $\frac{1}{2}$ " (13 mm.), width $\frac{7}{32}$ " (6 mm.). A female from near Marianna, Florida, measures as follows: total length $3\frac{17}{32}$ " (90 mm.), tail $1\frac{5}{8}$ " (42 mm.); head length $1\frac{3}{32}$ " (11 mm.), width $1\frac{1}{32}$ " (8.5 mm.).

DESCRIPTION. The head is widest just in front of the lateral extensions of the gular fold, where it is somewhat swollen, the sides converging gently to the eyes and more abruptly to the bluntly pointed snout. In the female the head is narrower and the sides less swollen. The eye is of moderate size, its horizontal diameter about $1\frac{1}{2}$ in the snout, and limited behind by a vertical fold. An impressed line from the posterior angle of the eye to the lateral extension of the gular fold; a vertical groove from this line passing behind the angle of the mouth. Trunk well rounded and with a median impressed line. There are usually 14 costal grooves, counting 1 in the axilla and 2 that come together in the groin, occasionally 15, and 4-6 intercostal folds between the toes of the ap-

pressed limbs. Tail stout at base, sometimes flattened above; rounded below, sharp-edged above beginning behind the vent, and keeled above on the distal half. Legs rather short and stout. Toes 5-4, those of the hind feet 1-5-2-4-3 in order of length from the shortest; toes of the

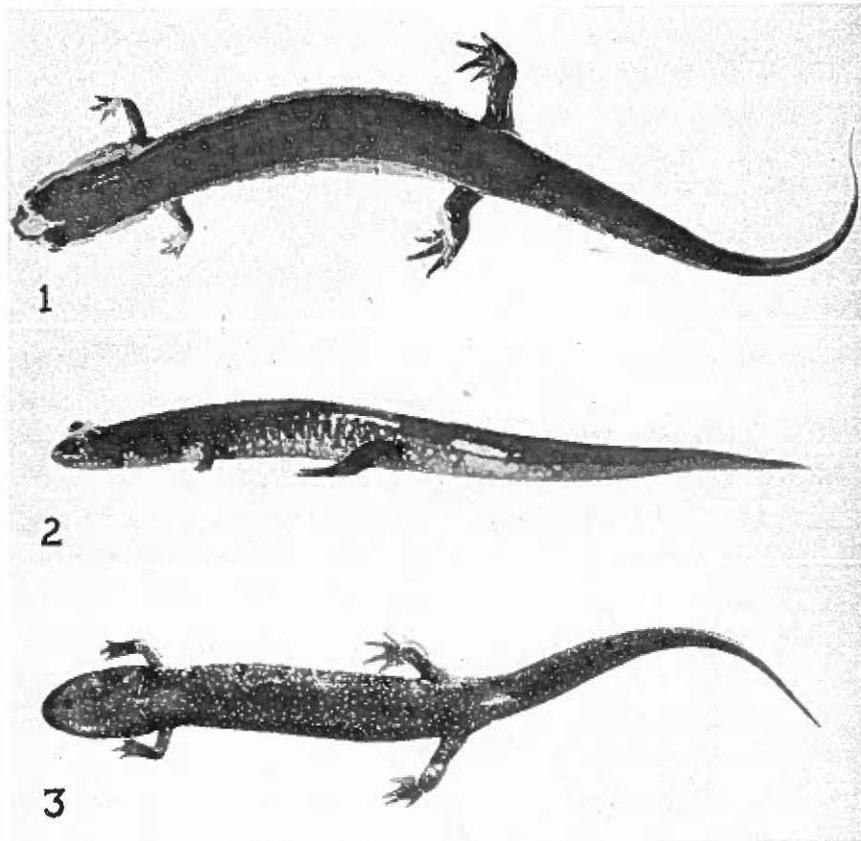


FIG. 52. *Desmognathus fuscus auriculatus* (Holbrook). (1) Adult male, actual length $3\frac{7}{16}$ " (88 mm.). (2) Same, lateral view. (3) Same, ventral view. Ferry Pass, Pensacola, Florida.

fore feet 1-4-2-3. Tongue widest behind, bluntly pointed in front, free at the sides and behind. Vomerine teeth lacking in adult males; in the females 3-6, in short series which arise behind the inner margin of the inner naris and slant obliquely backward toward the mid-line, where

they may be nearly in contact or separated by the width of a naris. Parasphenoid teeth in 2 slender patches widely separated from the vomerine.

COLOR. In life, above deep brown, almost black on the head, trunk and upper sides; bluish-gray on the lower sides, where there are many minute whitish specks. In old individuals there is scarcely an indication of a dorsal pattern on the trunk, but often, from the base of the tail well toward the tip, there is a conspicuous russet band with irregular edges. On the upper sides, a row of whitish or reddish spots extending from the back of the head onto the basal half of the tail, obscure in old, dark specimens. Often a second row of light spots on the lower sides between the legs. Belly dark, sometimes bluish-black and mottled with white, the ventral surface of the tail often brownish. On the side of the head from the eye to the angle of the jaw, a light mark which may be reduced to a line or may form an oval patch which varies in color from bright orange-red to russet. Half-grown individuals frequently exhibit a well developed dorsal light band with irregular dark edges.

BREEDING. Little is known of this subspecies.

LARVAE. The general ground color varies from light tan to dark brown. In most individuals there is an inconspicuous dorsolateral dark line or series of spots extending from the base of the gills onto the sides of the tail. The back between the dark lines is finely specked with brown pigment and a few larger, irregular brown spots disposed either in 2 much-broken lines or in a single median series. Along the upper edge of the dorsolateral dark line is a series of 7-9 small, pigment-free spots, 5-7 on the trunk, the rest on the tail. In many specimens there is a second series of light spots extending along the sides between the fore and hind legs and rarely onto the tail. Within most of these light spots there is a fleck of bright white pigment. The sides of the trunk below the dorsolateral dark lines are somewhat lighter than the back, and the head, legs, and sides of the tail are strongly pigmented and somewhat mottled. There is a light spot surrounding each nostril. The dark pigmentation of the sides encroaches in a narrow band around the

margin of the lower jaw, on the sides of the throat and belly, and to the mid-line of the venter of the tail. Unlike the larvae of many species of *Desmognathus*, these have the gills fairly long and slender and highly pigmented. A series of larvae from the vicinity of Gainesville, Florida, collected by A. F. Carr during January 1941, varied from 21 to 29 mm. in total length, and one individual with reduced gills was approaching transformation with a trunk length of 22 mm., the tip of the tail being lost.

BRIMLEY'S SALAMANDER. *Desmognathus fuscus brimleyorum* Stejneger.
Fig. 53. Map 23.

TYPE LOCALITY. Hot Springs, Arkansas.

RANGE. Northeastern Texas, southeastern Oklahoma, and Arkansas.

HABITAT. Under stones, rocks, logs, planks, and other debris in damp woods and in the vicinity of ponds and streams.

SIZE. The average length of 15 sexually mature individuals of both sexes from Rich Mountain, Oklahoma, is $4\frac{1}{2}$ " (113 mm.), the extremes $3\frac{1}{16}$ " (78 mm.) and $5\frac{1}{2}$ " (138 mm.). The proportions of an adult male from this locality are: total length $4\frac{3}{8}$ " (112 mm.), tail $2\frac{1}{2}$ " (52 mm.); head length $\frac{5}{8}$ " (16 mm.), width $\frac{3}{8}$ " (10 mm.). A female has the following measurements: total length $4\frac{3}{16}$ " (107 mm.), tail $2\frac{1}{2}$ " (52 mm.); head length $1\frac{1}{2}$ " (14 mm.), width $\frac{5}{16}$ " (8 mm.).

DESCRIPTION. The male has the head somewhat swollen in the region between the angle of the jaw and the lateral extension of the gular fold, the sides of the head in front of the angle of the mouth tapering gently to the eyes, then more abruptly to the bluntly pointed snout. In the female the sides of the head back of the eyes are nearly parallel and the snout is more broadly rounded. The eyes are large and strongly protuberant, the horizontal diameter about $1\frac{1}{4}$ in the snout. Eye limited behind by a vertical fold. An impressed line from the posterior angle of the eye to the lateral extension of the gular fold; a short vertical groove from this line passing behind the angle of the mouth. The trunk is stout and subcylindrical, slightly flattened below. There are usually

14 costal grooves, counting 1 each in the axilla and groin, with 2 in the groin sometimes running together, and 3-5 intercostal folds between the toes of the appressed limbs. Tail subquadrate in section at base, becoming rounded below, sharp-edged and keeled above behind the vent,

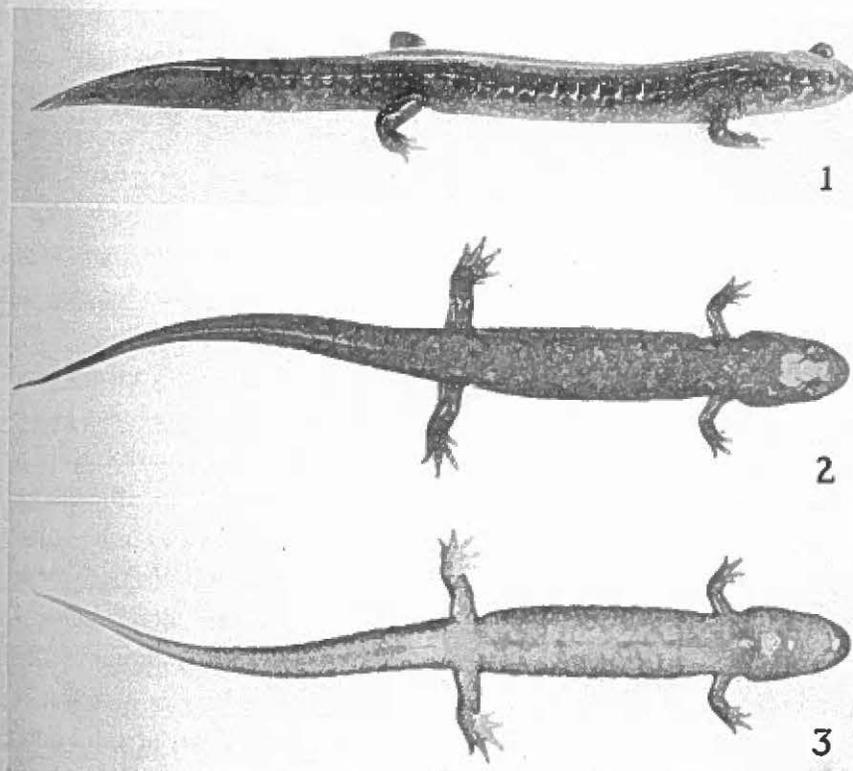


FIG. 53. *Desmognathus fuscus brimleyorum* Stejneger. (1) Adult, actual length about 4" (102 mm.). [Photograph by A. A. Heinze.] (2) Adult male, actual length $4\frac{3}{8}$ " (112 mm.). (3) Same, ventral view. Rich Mountain, Le Flore County, Arkansas.

and strongly compressed distally. The tail is relatively short in this species, in old males comprising 43-47.5 per cent of the total length and in the females 43-46.3 per cent. Young individuals of both sexes have proportionally longer tails than adults, in the males attaining 50.2 per cent and in the females 48.6 per cent. Legs rather large and stout. Toes

5-4, those of the hind feet 1-5-2-(4-3) in order of length from the shortest and slightly webbed at base; toes of the fore feet 1-4-2-3. Tongue broadly oval in outline, free at the sides and behind only. Vomerine teeth lacking in old and large males, sometimes retained in individuals until a length of $4\frac{25}{32}$ " (122 mm.) is attained, or lost at a length of $3\frac{23}{32}$ " (95 mm.); when present in males 5-7 in short series which arise between and behind the inner nares and curve inward and backward toward the mid-line, where they are separated by a little more than the diameter of a naris. In the female the series are longer, usually 7-11; they arise behind the inner margin of the inner nares and curve inward and backward, forming rows which are narrowly separated at the mid-line. Parasphenoid teeth in long, slender, narrowly separated patches; or, in older individuals, the patches shorter and in contact anteriorly.

COLOR. This is a large and somewhat variable species with the general color above brown or grayish-brown, fading slightly on the lower sides. In some the back is mottled with fine, worm-like, gray markings on a black ground and the lower sides are lightly mottled. In all but the largest and oldest individuals there is a series of light dashes or rounded spots on the sides which extends from the head or shoulder along the trunk above the level of the legs and is often continued along the sides of the tail. Very large specimens tend to be uniformly brownish. In small, half-grown, and medium-sized individuals there is a tendency to retain, on the basal half of the tail above, a light tan or brownish-yellow band with irregular dark edges. In some light-colored individuals there is a dorsolateral series of small, pale, dark-bordered spots extending from the shoulders along the trunk and basal quarter of the tail. In these individuals there is frequently an additional series of small light dots on the lower sides between the legs. The light bar from the posterior angle of the eye to the angle of the jaw is well developed in the young, frequently diffuse in the older individuals. The throat, belly, and ventral surface of the tail are finely pigmented with brown but are light in general tone—flesh or tinged with yellow.

BREEDING. Strecker (1908, p. 88), quoting from the notes of Combs, has given an account of the egg-laying: "In the latter part of August or early in September the female triton deposits her eggs, which are from 30 to 36 in number, and attached in strings, in a crevice in the under side of a rotten log or in a mass of decaying wood near some small stream. The eggs are about an eighth of an inch in diameter. The female is much attached to her eggs and seldom goes far away from them. During a dry spell she will carry them down into her hole with her, and if it rains again before they are hatched, will again bring them to the surface."

LARVAE. A larva 31 mm. long has the general ground color, brown, disposed in broken streaks along the sides of the trunk and tail. There is a dorsolateral series of round light spots with irregular edges extending along the trunk and on the basal third of the tail. The pigment extends on the side of the head to involve the extreme margin of the lower jaw, on the trunk to the lower level of the legs, and the entire tail. The throat and a narrow area along the venter of the belly immaculate.

ALLEGHENY MOUNTAINS SALAMANDER. *Desmognathus ochrophaeus ochrophaeus* Cope. Figs. 50c, 54. Map 24.

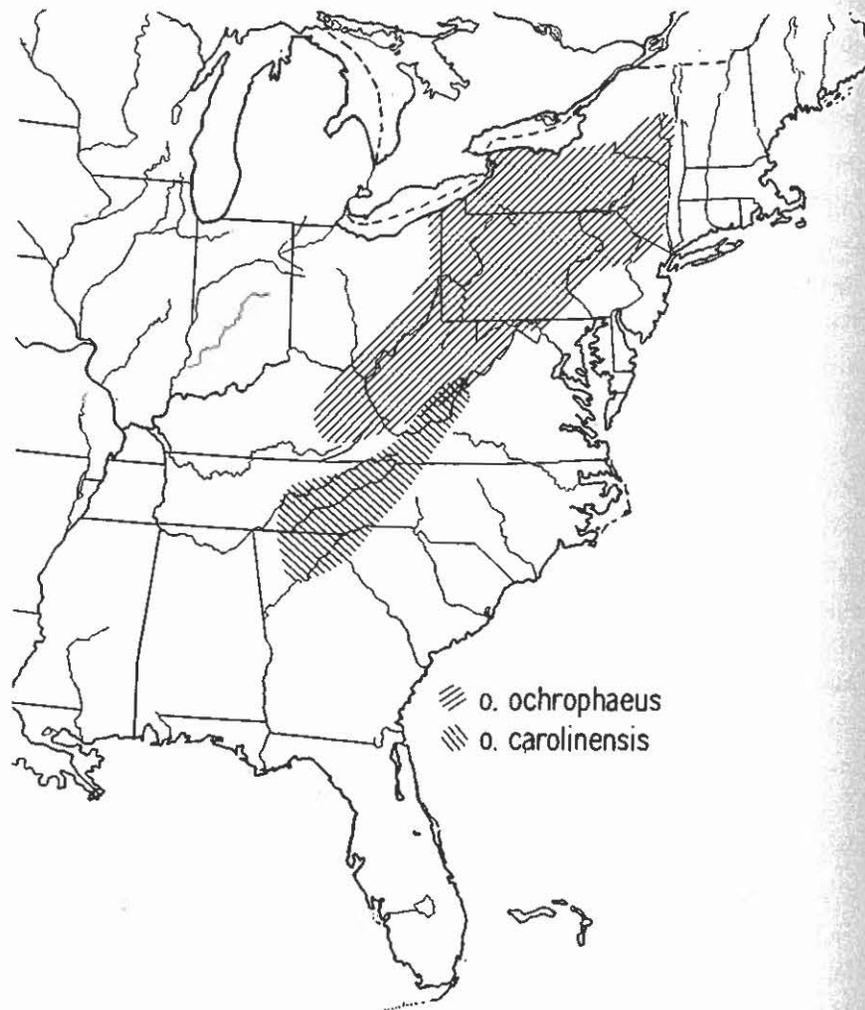
TYPE LOCALITY. Susquehanna County, Pennsylvania.

RANGE. Adirondack Mountains, New York, south to Virginia and West Virginia, west to Kentucky and northward into Ohio.

HABITAT. Found under logs, bark, stones, and moss, usually in the vicinity of streams and springs, but not restricted to such situations. Often found on hillsides a considerable distance from the nearest water. More terrestrial than *D. f. fuscus*, with which it is sometimes associated along stream banks.

SIZE. The average length of 40 males from the vicinity of Rochester, New York, is $2\frac{3}{4}$ " (70.33 mm.), the extremes $2\frac{3}{32}$ " (53 mm.) and $3\frac{3}{4}$ " (96 mm.). Forty females averaged $2\frac{27}{32}$ " (73 mm.) and varied from $1\frac{25}{32}$ " (46 mm.) to $3\frac{15}{32}$ " (88 mm.). The proportions of an adult male

are as follows: total length $3\frac{1}{16}$ " (78 mm.), tail $1\frac{1}{32}$ " (38 mm.); head length $1\frac{3}{32}$ " (10.5 mm.), width $\frac{9}{32}$ " (7 mm.). An adult female has the



MAP 24.—Distribution of the subspecies of *Desmognathus ochrophaeus*.

following measurements: total length $3\frac{1}{16}$ " (78 mm.), tail $1\frac{7}{16}$ " (37 mm.); head length $1\frac{1}{32}$ " (9 mm.), width $\frac{7}{32}$ " (5.5 mm.).

DESCRIPTION. This is a slender species with a well rounded, slim, and

tapering tail. The head of the male is widest just in front of the lateral extensions of the gular fold, slightly constricted at the angle of the jaws, the sides in front of this point converging to the bluntly pointed snout. In the female the sides of the head are nearly parallel back of the eyes. The eye is small, its long diameter about twice in the snout; limited behind by an oblique fold; the iris flecked with brassy. An impressed line from the posterior angle of the eye bends down posteriorly to the gular fold; a short vertical groove from this line to the angle of the jaw. A groove across anterior corner of upper lid. Trunk rounded above and on the sides, slightly flattened below. Costal grooves 14, counting 1 each in the axilla and groin, and $2\frac{1}{2}$ –4 intercostal spaces between the toes of the appressed limbs. Tail nearly circular in section, slender and tapering. No dorsal keel developed except when the tail has been lost and regenerated. Legs only moderately stout, the hind larger than the fore. Toes 5–4, those of the hind feet 1–5–2–4–3 in order of length from the shortest; toes of the fore feet 1–4–2–3. Tongue small, oval in outline, and without conspicuous plicae. Vomerine teeth lacking in the adult males; in the females the short series of 4–6 teeth arise behind the inner margin of the inner naris and curve gently inward and backward toward the mid-line, where they are separated by about the diameter of a naris. Parasphenoid teeth in 2 long slender patches divergent posteriorly and nearly or quite in contact anteriorly. Adult males with a small mental gland and pointed lower jaw; male vent with papillae.

COLOR. The color of the dorsal surfaces is extremely variable, but the pattern remains essentially constant. There is a broad, middorsal, light band with straight edges, below which the sides of the trunk and tail are dark, nearly black. The lower sides are generally mottled and fade into the lightly pigmented but scarcely mottled belly; throat and under surface of the limbs flesh color, lower surface of tail like belly. In old, dark individuals the dorsal light band may be almost obscured and the belly dark; in others the ground color may vary from light tan through various shades of gray, red, and brown. Within the band there is some-

times a median line of small black spots or scattered dark spots of various sizes and shapes. A small light bar extends from the posterior angle of the eye to the angle of the jaw.

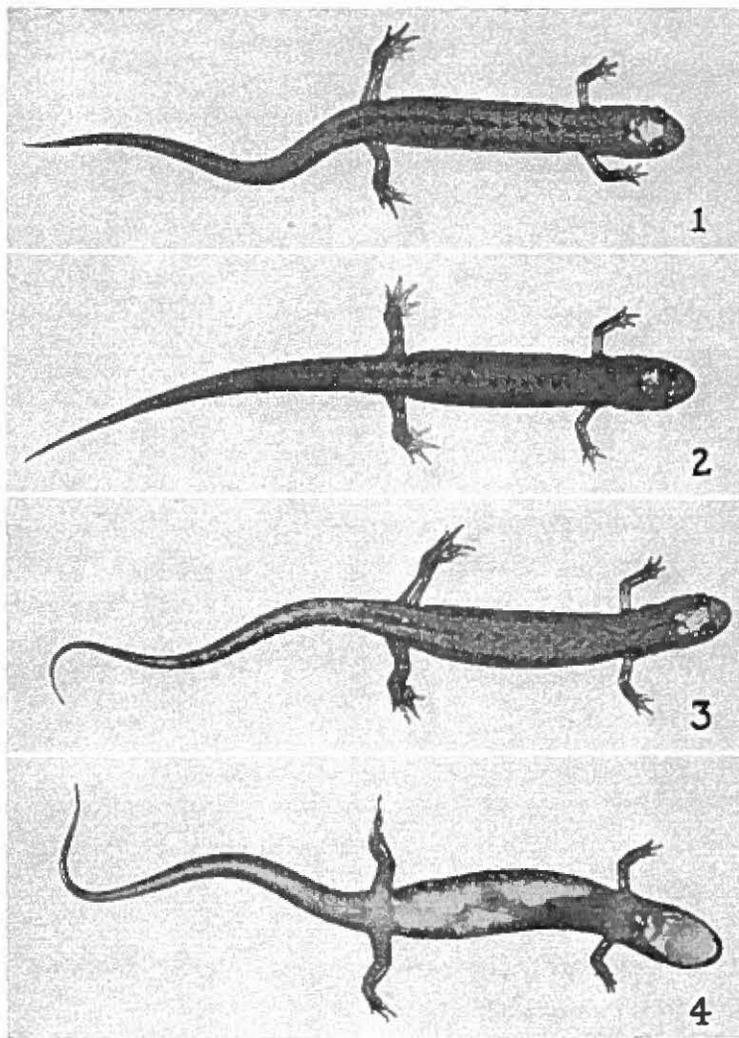


FIG. 54. *Desmognathus ochrophæus ochrophæus* Cope. (1) Adult male, actual length 3" (76 mm.). (2) Adult male, another individual, actual length 3 $\frac{5}{16}$ " (84 mm.). (3) Adult female, actual length 2 $\frac{3}{32}$ " (75 mm.). (4) Same, ventral view; note the eggs.

BREEDING. There is an extended late-summer-and-fall mating period, and considerable evidence to indicate an additional spring season of sexual activity. Eggs have been found beneath stones and logs on springy hillsides in August, September, and October, and recently hatched young throughout the late fall months and again in March. Spermatophores have been found both in the spring and fall (Bishop and Chrisp, 1933, p. 194). The eggs are deposited in small clusters of 11-14, occasionally in pairs or singly. The whitish, pigmentless eggs have a diameter, with the envelopes, of about 4 mm., and are attached to a common stalk by extensions of the outer envelope. The spermatophore is a small, stump-shaped mass of jelly surmounted by a whitish sperm cap.

LARVAE. At hatching the larvae average about 17 mm. They have a broad, median, light band extending from back of the eyes to the end of the tail; the band is limited on either side by a darker line of pigment; the sides of the trunk and tail lightly mottled. The dorsal light band lacks the conspicuous, dark-bordered light spots characteristic of *D. f. fuscus*, *D. o. carolinensis* and *D. phoca*, but is lightly mottled. Short white gills are present at hatching and are retained for a short time.

CAROLINA MOUNTAIN SALAMANDER. *Desmognathus ochrophæus carolinensis* Dunn. Figs. 50a, d; 55. Map 24.

TYPE LOCALITY. Mt. Mitchell, North Carolina.

RANGE. From Virginia and West Virginia south to Georgia in the mountains.

HABITAT. Generally terrestrial and found under logs, stones, and bark, often a considerable distance from water. During the egg-laying season most abundant in the vicinity of streams and springs.

SIZE. Forty adults of both sexes from North Carolina and Tennessee average 3 $\frac{1}{8}$ " (80 mm.) and range from 2 $\frac{5}{32}$ " (55 mm.) to 4 $\frac{3}{32}$ " (104.4 mm.). Dunn (1926, p. 109) records a male 4 $\frac{1}{32}$ " (113 mm.) in total length. The proportions of an adult male from Indian Gap, Tennessee, are as follows: total length 3 $\frac{25}{32}$ " (97 mm.), tail 1 $\frac{7}{8}$ " (48 mm.); head length 1 $\frac{3}{32}$ " (12 mm.), width $\frac{5}{16}$ " (8 mm.). A female from the

same locality: total length $3\frac{3}{8}$ " (86 mm.), tail $1\frac{1}{16}$ " (43 mm.), head length $1\frac{3}{32}$ " (11 mm.), width $\frac{1}{32}$ " (7 mm.).

DESCRIPTION. In general conformation similar to *D. o. ochrophaeus*. The head of the male is somewhat swollen between the lateral extensions of the gular fold and the angle of the jaw, where there is a constriction; in front of this point the sides converge to the bluntly pointed snout. In the female the sides of the head nearly parallel back of the eyes. Eyes moderate and limited behind by a vertical fold; a groove across the anterior corner of the upper lid. A sinuous impressed line from the posterior angle of the eye to the lateral extension of the gular fold, a short vertical groove from this line passing back of the angle of the jaw. Trunk rounded above, with an impressed median line. Costal grooves usually 14 but ranging from 13 to 15, counting 1 each in the axilla and groin, often the one in the groin forked above; 3-5 intercostal folds between the toes of the appressed limbs. Tail nearly round throughout its length, long, slender, and tapering; no keels. Legs stouter than in *D. o. ochrophaeus*; toes 5-4, those of the hind feet 1-5-2-(4-3) in order of length from the shortest; toes of the fore feet 1-4-2-3. Tongue broadly oval in outline, free at the sides and behind, the surface spongy. Vomerine teeth lacking in the adult males; in the females the short series of 5-7 teeth lie between and behind the inner nares and slant inward and backward toward the mid-line, where they are separated by about the diameter of a naris. Parasphenoid teeth in 2 elongate patches which may be completely separated or narrowly in contact anteriorly, slightly diverging posteriorly. The vent of the male is lined anteriorly with short papillae and the tip of the lower jaw is pointed and bears a small mental gland. In the female the sides of the vent are thrown into folds and the tip of the jaw is broadly rounded.

COLOR. Extremely variable in color and pattern. Old individuals may be uniformly bluish-black above, with rusty mottlings on the head, and with the legs lighter than the back. In these the belly is finely reticulated with black pigment and a few scattered light flecks. Many individuals have a dorsal pattern consisting of a broad, median, light band with

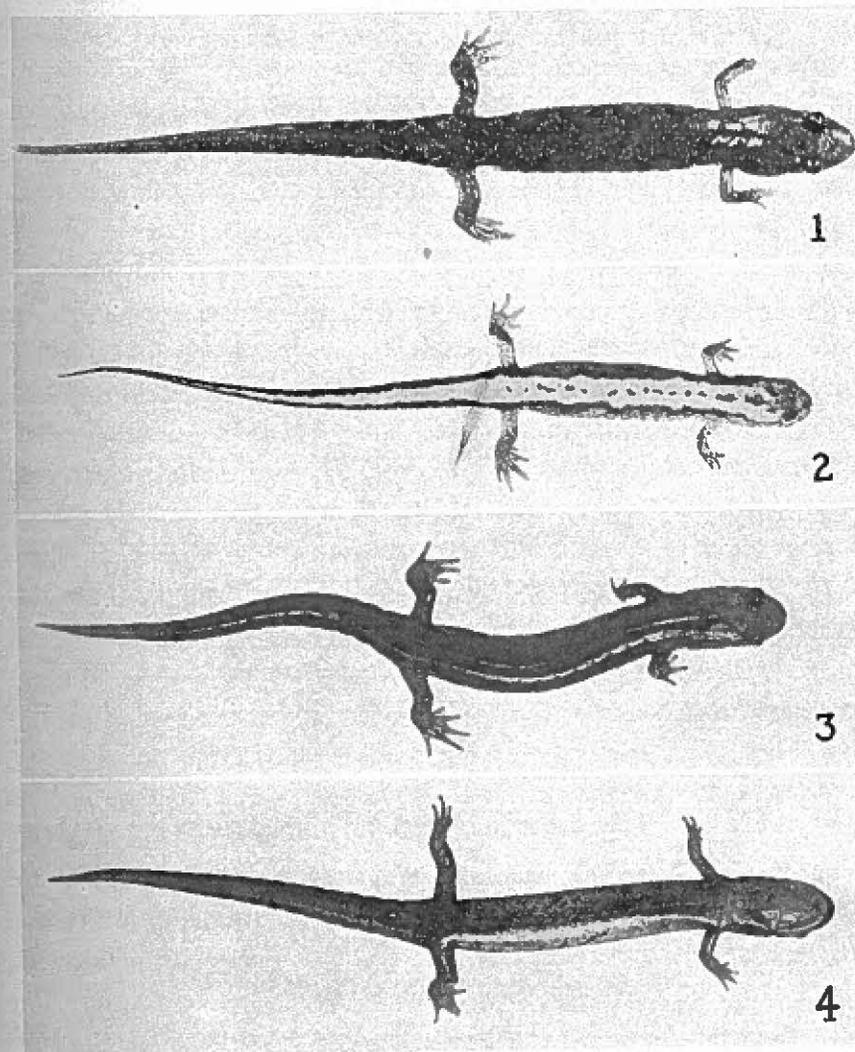


FIG. 55. *Desmognathus ochrophaeus carolinensis* Dunn. (1) Adult male, actual length $2\frac{3}{32}$ " (75 mm.). Jocassee, South Carolina. (2) Adult female, actual length $3\frac{1}{4}$ " (82 mm.). Eight miles west of Blowing Rock, North Carolina. (3) Adult female, actual length $4\frac{1}{16}$ " (103 mm.). (4) Same, ventral view. Near Grandfather Mountain, North Carolina.

irregular or evenly scalloped edges. The upper sides bordering the light band are dark, fading gradually on the lower sides to the belly, which is always finely pigmented with black but lighter than the back. Other individuals may have a dorsal series of black-bordered light areas set in a zigzag pattern and representing the remnants of the larval light spots. The dorsal light areas may be of varying shades of yellow, brown, red, or gray.

BREEDING. During the period in which the eggs are found, July and August, the adults in attendance are to be found in the vicinity of shaded brooks and springy areas beneath dead leaves, in mud, and among moss-covered rocks. The eggs are deposited in small clusters, held together like a bunch of toy balloons by extensions of the outer envelope, and average about 10 in number but vary from 2 or 3 to 18. Individual eggs in early stages of development have a diameter of approximately 3 mm., increasing in size with development to 4.5 mm. (Pope, 1924, p. 4). Eggs preserved in formalin do not show the envelopes well and they have not been described.

LARVAE. Larvae at hatching have an average length of about 16 mm. and vary from 15 to 18 mm. There is considerable variation in the dorsal markings even in the young larvae. Often the dorsal dark-bordered light spots form a zigzag series; sometimes they are united in pairs which are connected by the middorsal light stripe. Occasionally there is a single broad median band with irregular edges. I have measured completely transformed individuals only 21 mm. long, and larvae with gills 23 mm. in length. The gills are short and stubby, pigmented at base, and with only a few short filaments.

SEAL SALAMANDER. *Desmognathus phoca* (Matthes). Fig. 56. Map 25.

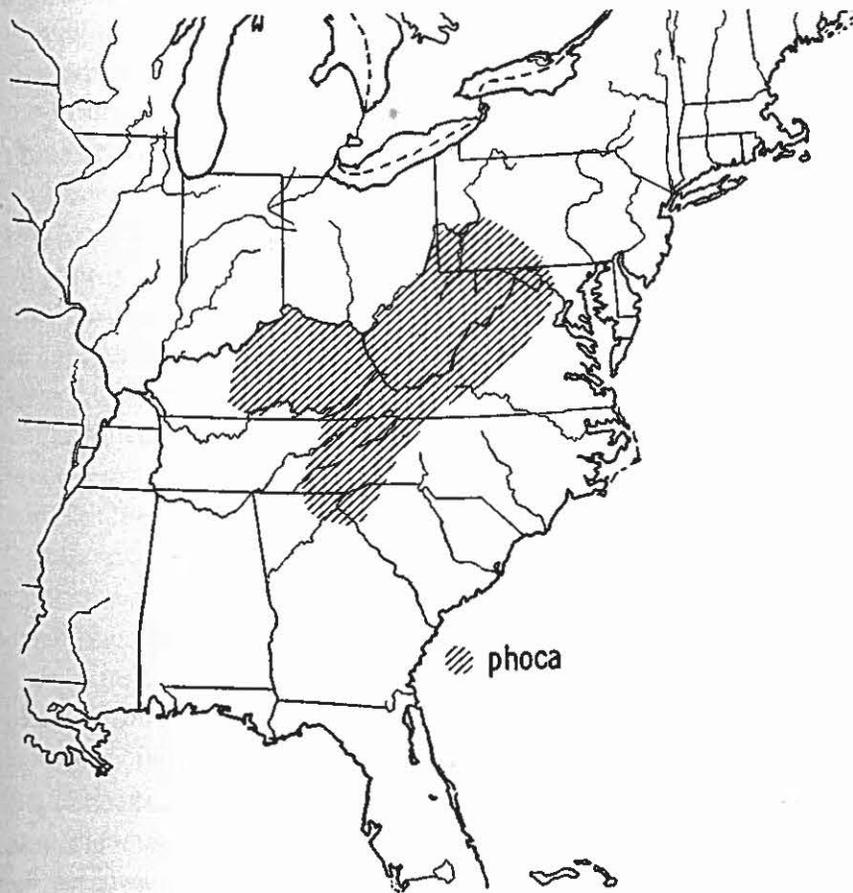
TYPE LOCALITY. Taylor's Creek near Newport, Kentucky.

RANGE. From Pennsylvania south through Virginia, West Virginia, North Carolina, South Carolina, Georgia, Tennessee, and Kentucky, in the mountains.

HABITAT. Most abundant about the margins of mountain brooks and

springs or in cool, well shaded ravines. They are to be found beneath logs, bark, and stones, and sometimes in shallow, muddy streams.

SIZE. The average length of 20 adults of both sexes from North Caro-



MAP 25.—Distribution of *Desmognathus phoca*.

lina and Tennessee is $4\frac{1}{32}$ " (111 mm.), the extremes $3\frac{1}{32}$ " (77 mm.) and $5\frac{1}{8}$ " (131 mm.). The proportions of an adult female are as follows: total length $3\frac{3}{32}$ " (101 mm.), tail 2" (51 mm.); head length $\frac{1}{2}$ " (13 mm.), width $\frac{5}{16}$ " (8 mm.). A male has the following measurements: total length $4\frac{3}{8}$ " (112 mm.), tail $2\frac{1}{8}$ " (54 mm.); head length $\frac{5}{8}$ " (16

mm.), width $1\frac{1}{32}$ " (9 mm.). Dunn (1926, p. 77) recorded transformed individuals only $1\frac{7}{32}$ " (31 mm.) in total length.

DESCRIPTION. The head is widest about midway between the eyes and the lateral extensions of the gular fold, and from this point the sides behind converge slightly, and in front more abruptly, to the bluntly pointed snout. The eyes are large and strongly protuberant, the horizontal diameter about $1\frac{1}{3}$ in the snout. A vertical fold immediately behind the eye; a light bar from the posterior angle of the eye to the angle of the jaw. An impressed line from the posterior angle of the eye to the lateral extension of the gular fold and a vertical groove crossing this line just behind the angle of the mouth. The trunk is rounded above and with a median groove, flattened beneath. There are usually 13 costal grooves, counting 1 in the axilla and 2 that run together in the groin, or 14 if the 2 in the groin are counted separately; but often the space between these and the next beyond is less than that between the other grooves. Intercostal folds 4-5 between the toes of the appressed limbs. Tail subquadrate in section at base, becoming sharp-edged above, rounded below beyond the vent, and compressed and slightly keeled above toward the slender, pointed tip. Legs stout; toes 5-4, those of the hind feet usually 1-5-2-4-3 in order of length from the shortest, the 3rd and 4th about equal; toes of the fore feet 1-4-2-3 or 1-2-4-3. The tongue is broad behind, narrowed and bluntly pointed in front, the surface spongy; free at the sides and behind. Vomerine teeth usually retained in adult males; when present in short, nearly transverse rows of 3-4 teeth, which may arise behind inner margin of inner nares or lie wholly between and slightly behind the nares, the series widely separated at the mid-line. Vomerine series in female longer, with 5-7 teeth. Parasphenoid teeth in 2 elongate, imperfectly separated patches, often in contact anteriorly and slightly divergent behind. In some males united for nearly the whole length.

COLOR. While variable in its dorsal markings, this salamander usually gives the impression of being very light below and strongly blotched above. The ground color of the light areas above varies from light buff

to grayish-brown. The light areas may have dark borders and form fairly regular pairs along the back and become fused on the tail; or the light areas alternate with one another, with dark interspaces. Sometimes the light areas occupy the entire dorsal surface with only the outer margins limited by dark. The upper sides are usually more lightly mottled and fade on the lower sides to the light venter. The ventral surfaces may

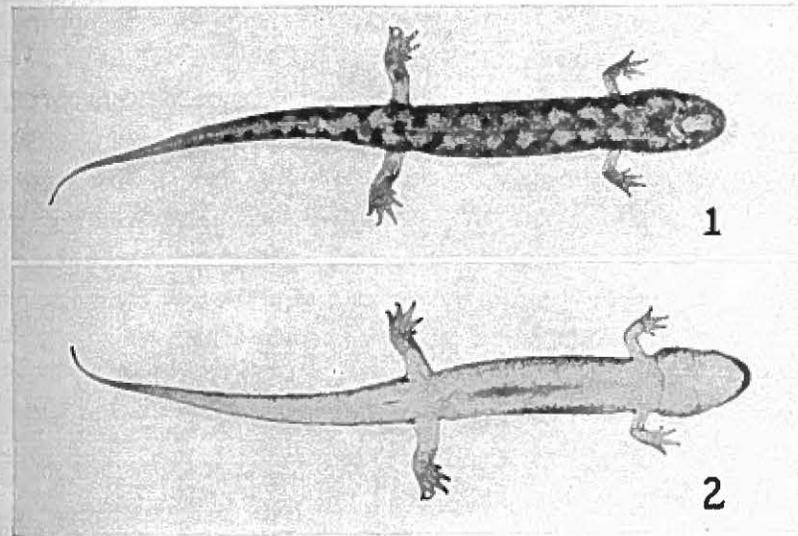


FIG. 56. *Desmognathus phoca* (Matthes). (1) Adult male, actual length $4\frac{3}{8}$ " (112 mm.). (2) Same, ventral view. Near Pine Ridge, Kentucky. [From a preserved specimen.]

be evenly but lightly pigmented with minute chromatophores, or the pigment may be aggregated to give a lightly mottled effect. The tip of the lower jaw of the male is slightly pointed and bears a mental gland, and the vent within is lined with papillae. The lower jaw of the female is broadly rounded, and the sides of the vent are thrown into folds.

BREEDING. The eggs of this species were first reported by Brady (1924, p. 29), who found a female coiled about a lot of 17 hatched eggs and 12 larvae near Harper's Ferry, Virginia, Sept. 5, 1923. Pope (1924, p. 7) reported additional lots found in the vicinity of Flat Rock and the

base of Trenholm Mountain, North Carolina. The first group found by Pope, July 27, consisted of a cluster of 30 eggs attached to the lower side of a stone which was supported by other smaller stones above the bed of a clear brook. The second lot of 21 eggs, accompanied by a female, was taken August 1 in the cavity of a decayed, moss-covered log. Apparently in most instances the eggs are attached singly by extensions of the outer envelope. Brady recorded individual eggs as having a diameter of $2\frac{1}{4}$ mm., and Pope gave a measurement of 5 mm., apparently the diameter of the outer envelope.

LARVAE. I have not seen the recently hatched larvae, but Brady (*ibid.*) has described them as 18–20 mm. long and "having a row of well defined light spots each side of the dorsal groove from its beginning to the base of the tail." My smallest transformed specimen, 34 mm. in total length, has 6 pairs of narrowly separated light spots between the back of the head and the base of the tail and several offset confluent pairs on the basal half of the tail.

BLACK-BELLIED SALAMANDER. *Desmognathus quadramaculatus quadramaculatus* (Holbrook). Fig. 57. Map 26.

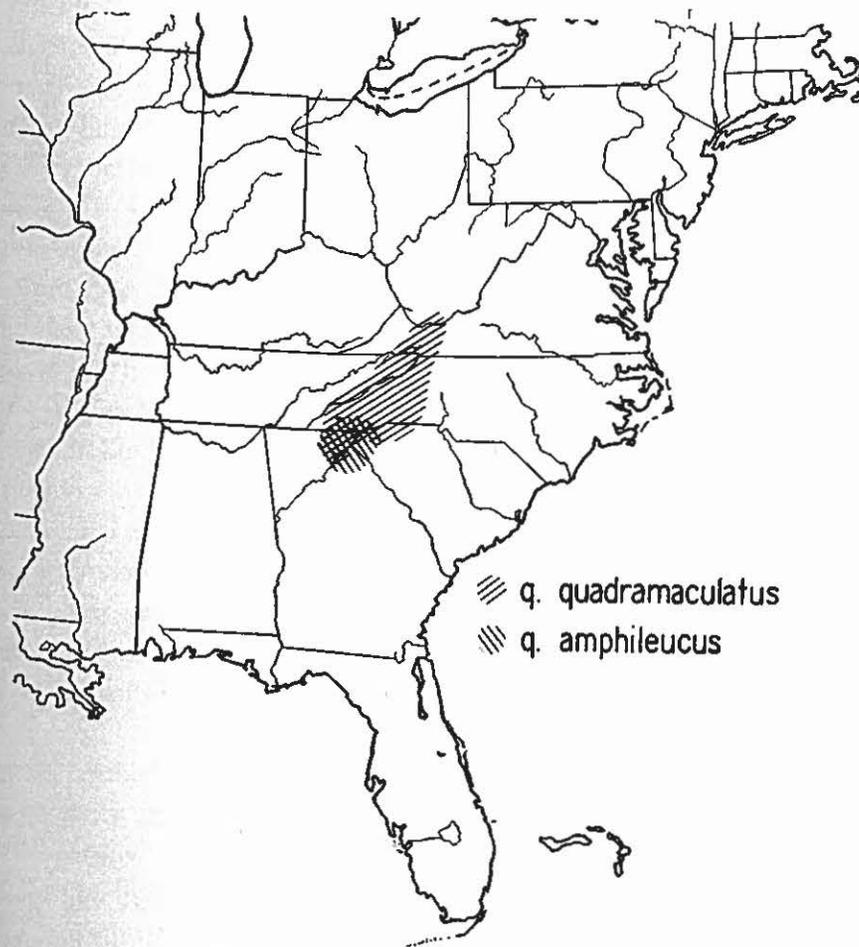
TYPE LOCALITY. Georgia and the Carolinas.

RANGE. From West Virginia and Virginia southward through the mountains to northern Georgia.

HABITAT. I have found this species in greatest numbers in and along the mountain streams above 2500'. They are particularly abundant where boulder-paved streams tumble in steep cascades down wooded ravines.

SIZE. Largest among the species of the genus, *D. quadramaculatus* attains an extreme length of $7\frac{5}{16}$ " (186 mm.) (Caesar's Head, South Carolina). The average length of 35 adults of both sexes from North Carolina and Tennessee is $4\frac{1}{2}$ " (118 mm.), the extremes $2\frac{13}{32}$ " (61 mm.) and $6\frac{1}{8}$ " (175 mm.). The proportions of an adult male from Mt. Le Conte, Tennessee, are as follows: total length $6\frac{5}{8}$ " (168 mm.), tail $2\frac{29}{32}$ " (74 mm.); head length $1\frac{1}{16}$ " (27 mm.), width $\frac{5}{8}$ "

(16 mm.). An adult female from the same locality measures: total length $5\frac{7}{32}$ " (133 mm.), tail $2\frac{7}{16}$ " (62 mm.); head length $2\frac{25}{32}$ " (20 mm.), width $1\frac{9}{32}$ " (15 mm.).



MAP 26.—Distribution of the subspecies of *Desmognathus quadramaculatus*.

DESCRIPTION. The head is large, somewhat swollen between the angle of the jaws and the lateral extensions of the gular fold, the sides in front of the angle of the mouth gradually converging to the bluntly rounded and depressed snout. The eyes are moderately large and pro-

tuberant, the long diameter about $1\frac{1}{2}$ in the snout; limited behind by a vertical fold. A lightly impressed line from the posterior angle of the eye to the lateral extension of the gular fold; a deep groove from this line passing behind the angle of the mouth; a narrow light line from the posterior angle of the eye to the angle of the jaw. The trunk is large and strong and with an impressed median line above. There are usually 14 costal grooves, counting 1 each in the axilla and groin, or 15 if 2 that run together in the groin are counted separately; 2-3 intercostal folds between the toes of the appressed limbs. Tail subquadrate in section at base, rounded below, sharp-edged and keeled above beyond the vent. The dorsal tail keel arises as a low ridge immediately behind the vent and is thin and free beginning about at the basal third. Legs large and stout. Toes 5-4, those of the hind feet 1-5-2-3-4 in order of length from the shortest; toes of the fore feet 1-4-2-3. Tongue broadly oval in outline, free at the sides and behind, the surface broken into deep irregular folds. Vomerine teeth in series of 5-12, usually about 9, which arise back of the inner margin of the inner naris and curve inward and backward toward the mid-line, where they are separated by about the diameter of a naris; parasphenoid teeth in 2 long narrow patches narrowly separated or slightly in contact anteriorly, separated from the vomerine by 2 or 3 times the diameter of a naris.

COLOR. In old adults the ground color of the back and sides is black. Scattered over these areas and sometimes aggregated on the back to form irregular blotches are small greenish-yellow dots which give a rusty appearance. On the sides there is often a series of small light spots at the level of the eye and a second row between the legs at the juncture of the sides and belly. The belly and ventral surface of the tail and legs are black; the throat may be dark, strongly mottled black and dull yellow, or quite uniformly dusky yellowish. The back of the head and the snout are often rusty and sometimes there is a rusty spot at the base of the tail above. The dorsal surface of the legs is dark and quite uniformly pigmented, the soles of the feet light flesh color. In half-

grown individuals the back and upper sides are dark, the lower sides light and mottled, the venter dark and lightly flecked with yellow. Re-

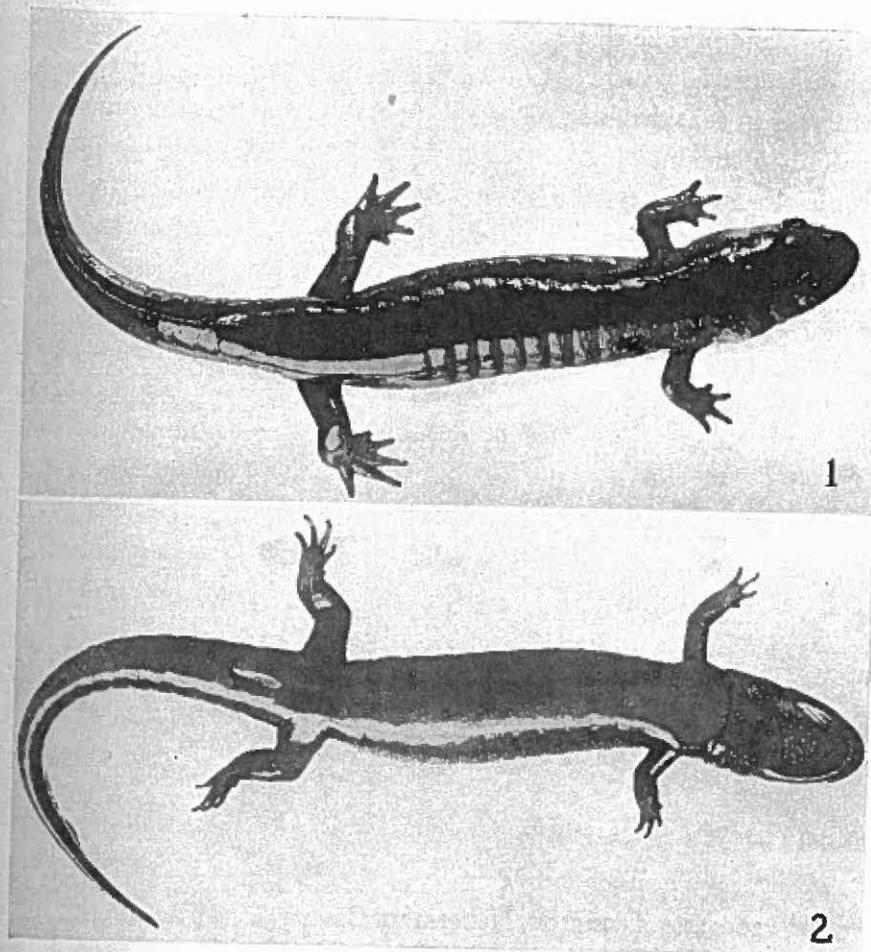


FIG. 57. *Desmognathus quadramaculatus quadramaculatus* (Holbrook). (1) Adult male, actual length $6\frac{7}{8}$ " (168 mm.). Mount Le Conte, Tennessee. (2) Adult female, actual length $5\frac{7}{8}$ " (143 mm.). Indian Gap, Tennessee.

cently transformed individuals are generally dark gray or brown above and light below, and many retain indications of the light larval markings as paired spots along the back and basal half of the tail.

BREEDING. In the disposition of the eggs, *D. quadramaculatus* resembles *D. phoca* and differs from the majority of the species of the genus in that they are attached singly to the lower surface of a support, usually a stone, and may be either submerged beneath the surface of the water or suspended above it. Pope (1924, p. 8) found the eggs and developing embryos in considerable numbers during July and early August in the mountain streams of North Carolina, and has indicated that normal complements may contain 25-40. The eggs are unpigmented and have a diameter of 5-6 mm. when well advanced in development. Each egg is attached by a slender pedicel, an extension of the outermost of the two jelly envelopes.

LARVAE. Larvae soon after hatching have a length of 20 mm. and are represented in Pope's figure (p. 10) as being uniformly pigmented on the back and sides except for a series of small pale spots along either side of the middorsal line of the back and basal half of the tail. The dorsal tail fin has its origin above the insertion of the hind legs and extends to the bluntly pointed tip; the ventral fin is narrower and does not reach the vent. Both fins are lightly mottled. Larger larvae are quite uniformly pigmented above and light below. Often the light larval marks are retained as paired spots narrowly separated along the mid-line of the back. Larvae may attain a length of $3\frac{1}{2}$ " (89 mm.) before losing the gills, or transform at less than 2" (51 mm.).

WHITE-HEADED SALAMANDER. *Desmognathus quadramaculatus amphileucus* Bishop. Fig. 58. Map 26.

TYPE LOCALITY. Demorest, Habersham County, Georgia.

RANGE. KNOWN only from the type locality.

HABITAT. I know nothing of the circumstances under which the specimens were found.

SIZE. Only three specimens are known. The type has measurements as follows: total length $3\frac{17}{32}$ " (90 mm.), tail $1\frac{5}{8}$ " (41 mm.); head length $1\frac{7}{32}$ " (13 mm.), width $1\frac{1}{32}$ " (9 mm.). Two paratypes measure respec-

tively $3\frac{1}{8}$ " (80 mm.) and $3\frac{5}{32}$ " (81 mm.), the smaller specimen with the tip of tail lost.

DESCRIPTION. A salamander of moderate size having the head, distal half of the tail, and the limbs white or lightly pigmented. The head has the sides back of the eyes gently converging to the lateral extensions of

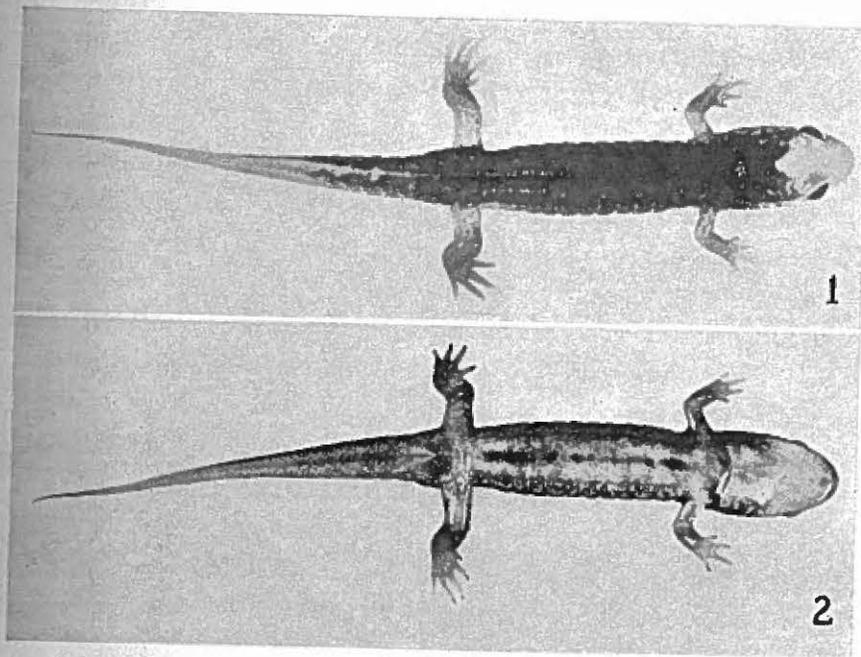


FIG. 58. *Desmognathus quadramaculatus amphileucus* Bishop. (1) Adult female, actual length $3\frac{17}{32}$ " (90 mm.). (2) Same, ventral view. Type, from Demorest, Habersham County, Georgia.

the gular fold, in front more abruptly narrowing to the bluntly pointed snout. The eye is large and strongly protuberant, the horizontal diameter slightly less than the length of the snout. The trunk is slightly depressed and with a median impressed line, the sides rounded. There are 14 costal grooves, counting 1 in the axilla and 2 that run together in the groin and about 1 intercostal fold between the toes of the appressed limbs. Tail subquadrate in section at base, becoming compressed and

keeled above immediately behind the vent; ventral tail keel narrow and limited to the distal third. Legs moderately stout; toes 5-4, those of the hind feet 1-5-2-4-3 in order of length from the shortest, webbed at base; toes of the fore feet 1-4-2-3. Tongue broadly heart-shaped, thin at the margins and free at the sides and behind, the plicae narrow and radiating from the center toward the sides and anterior margin. Vomerine teeth 7-10 in the females, in short series which arise slightly behind and inside the inner margin of the inner nares and curve inward and backward toward the mid-line, where they are separated by about the diameter of a naris. Parasphenoid teeth in 2 long, slender, club-shaped patches, slightly in contact anteriorly and separated from the vomerine by about twice the diameter of a naris.

COLOR. The general color above is dark brown, with the white of the head including the eyes and extending backward in a triangular point behind them, extending on the sides of the head to include the jaws and part of the neck, and on the ventral side halfway from the tip of the lower jaw to the gular fold. The distal half of the tail and the limbs white or lightly pigmented. The general brown color of the basal part of the tail and the upper sides is relieved by narrow light markings along the costal grooves and vertical grooves of the tail. The lower sides are mottled, yellowish-white and brown, the ventral surfaces lightly pigmented with brown except as noted above.

Intergrades between this subspecies and typical *quadramaculatus* have been noted in the general region about Demorest. They are generally larger than *amphileucus* and have the head, tail, and limbs lightly pigmented but suggesting the pattern as it is developed in this form.

BREEDING. Nothing is known of the breeding habits or larvae of this form.

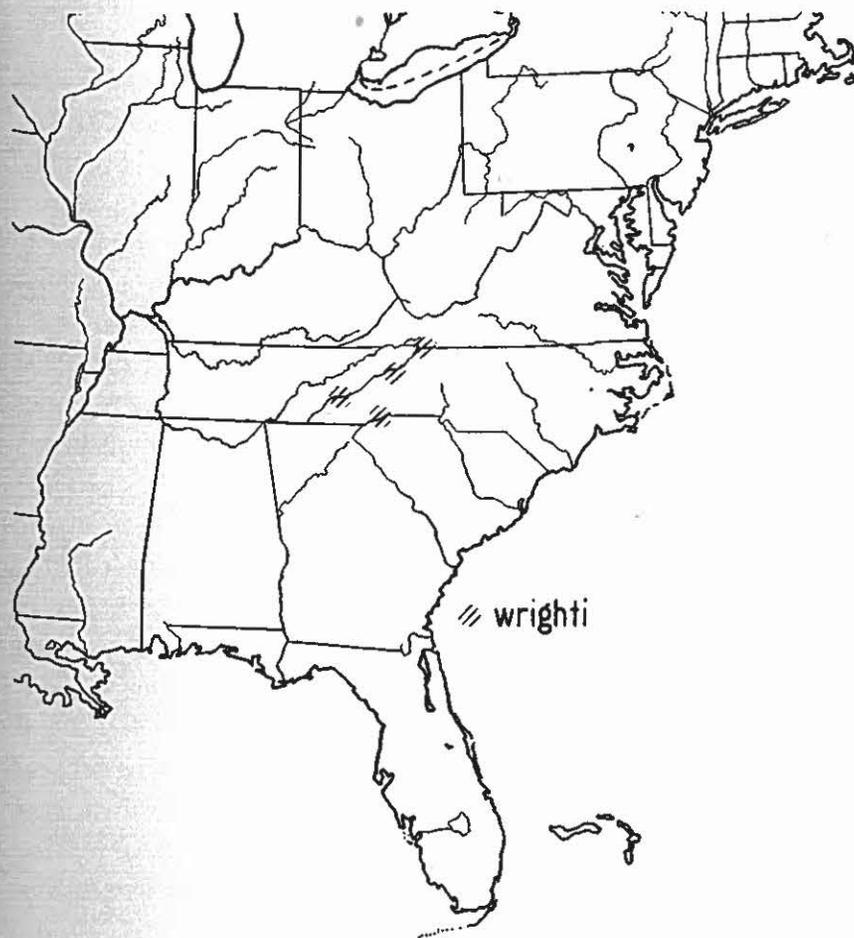
PYGMY SALAMANDER. *Desmognathus wrighti* King. Fig. 59. Map 27.

TYPE LOCALITY. Mt. Le Conte, Sevier County, Tennessee.

RANGE. The spruce-fir forests of the Great Smoky Mountains in eastern

Tennessee; the mountains of western North Carolina northward to Whitetop Mountain, Virginia.

HABITAT. This is a terrestrial species found beneath stones, logs, bark,



MAP 27.—Distribution of *Desmognathus wrighti*, a species limited to high elevations.

and moss, usually at elevations above 5000' but occasionally as low as 3500'. On Clingman's Dome and Mt. Le Conte, Tennessee, reaches an elevation of 6500'.

SIZE. This is a diminutive species which attains an extreme length of about 2". King (1936, p. 58) gives the measurements of 12 individuals from North Carolina and Tennessee which average $1\frac{1}{16}$ " (42.9 mm.) in total length and range from $1\frac{7}{16}$ " (37 mm.) to $1\frac{29}{32}$ " (49 mm.). The proportions of an adult male from Mt. Le Conte, Tennessee, are as follows: total length $1\frac{5}{8}$ " (42 mm.), tail $1\frac{1}{16}$ " (18 mm.); head length $\frac{7}{32}$ " (6 mm.), width $\frac{5}{32}$ " (4 mm.). A female from Grandfather Mountain, North Carolina, measures: total length $1\frac{27}{32}$ " (47 mm.), tail $2\frac{3}{32}$ " (19 mm.); head length $\frac{7}{32}$ " (6 mm.), width $\frac{5}{32}$ " (4 mm.).

DESCRIPTION. The sides of the head back of the eyes are nearly parallel, the snout short and bluntly rounded. Eye limited behind by an oblique fold, moderate, the long diameter about $1\frac{1}{4}$ in the snout; the iris tinged with brassy. A sinuous groove from the posterior angle of the eye to the lateral extension of the gular fold, a short vertical groove from this extending to the angle of the mouth. Trunk rounded, belly flattened. There are usually 14 costal grooves, counting 1 each in the axilla and groin, or 13 when 2 in the groin run together, and about 4 intercostal folds between the toes of the appressed limbs. The tail is flattened above at base, becoming circular in section beyond the vent, slender and tapering. Legs small but well developed. Toes 5-4, those of the hind feet 1-5-2-4-3 in order of length from the shortest; toes of the fore feet 1-4-2-3. Tongue wide behind, bluntly pointed in front, free at the sides and back. Vomerine teeth 3-7 in short series that arise between and behind the inner nares and curve inward and backward toward the mid-line, where they may be nearly in contact or separated by a distance equal to the diameter of a naris. Parasphenoid teeth in 2 slender, club-shaped patches in contact anteriorly.

COLOR. This small species has a light dorsal band and light belly. In most the light band arises on the snout and involves the full width of the head, narrowing down slightly at the shoulders and continuing to the tip of the tail. The light band varies in color from light tan to red, with the majority of specimens exhibiting a bronzy or reddish-brown tinge. In some individuals the sides of the band are fairly regular;

in others the remnants of the light larval spots persist as half-circles arranged opposite one another or alternating along the sides of the band. Many specimens have a definite herringbone pattern of black along the mid-line of the back, each segment separated from its fellow by a dash of yellow. Legs above reddish-orange mottled with brown and gray; feet tan and brown. On the side of the head a dark bar from the nostril through the eye and an oblique orange-yellow bar from the

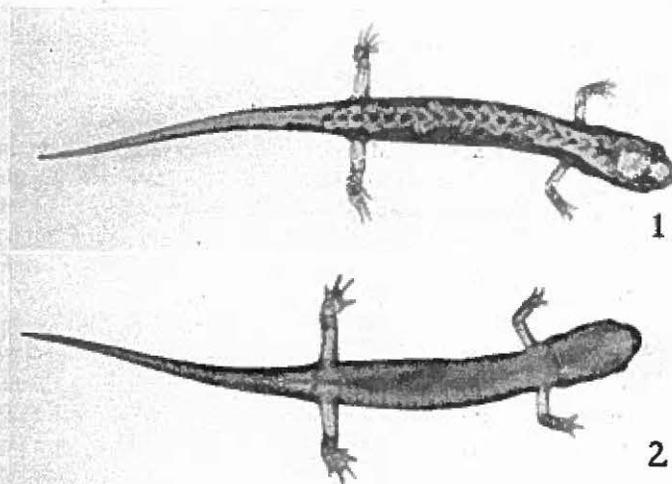


FIG. 59. *Desmognathus wrighti* King. (1) Adult female, actual length $1\frac{5}{8}$ " (41 mm.). (2) Same, ventral view. Grandfather Mountain, North Carolina.

posterior angle of the eye to the angle of the jaw. Sides of head behind jaw, and the trunk next to the dorsal band tan to brown lightly flecked with white, becoming lighter toward the belly. Belly lightly pigmented at sides, flesh color in life, yellowish-white in preservative; ventral surface of legs and tail tan, throat flesh with silvery reflections. Margins of lower jaw usually mottled with brown and tan.

BREEDING. Nothing has been reported on the breeding habits. King (*ibid.*, p. 59) dissected two females taken Sept. 23, 1934, each 45 mm. long, which contained 13 and 14 eggs respectively. The egg-laying season may be an extensive one, for a female taken July 22, 1937, on Cling-

man's Dome, and sent me by Dr. A. H. Wright, had large ovarian eggs which showed through the skin of the belly. On April 18 and 19, 1938, we collected this species in some numbers on Grandfather Mountain, North Carolina, at elevations above 5000'. Here they were in fairly dry situations, beneath stones and bits of logs and bark along the trail. At Indian Gap, Tennessee, they were in somewhat moister situations in the spruce-fir forests.

GENUS LEUROGNATHUS

KEY TO THE SUBSPECIES OF LEUROGNATHUS MARMORATA

- Above mottled with shades of buff and dark gray or black, the light and dark patches often forming a broad zigzag pattern; belly mottled and blotched along the sides, usually lighter centrally; vomerine teeth usually lacking in adults of both sexes, 2 or 3 sometimes present in the female; length to $5\frac{1}{16}$ " (128 mm.). Western North Carolina and Roan Mountain, Carter County, Tennessee *marmorata marmorata* p. 220
- Above dark brown with dorsolateral series of rounded, well separated light spots extending from the head onto the basal half of the tail; belly uniformly mottled and blotched and without a light central area; vomerine teeth usually lacking in adult male, occasionally 1 or 2 present; vomerine teeth in female variable, usually 1 or 2 on each side; length to $4\frac{13}{16}$ " (122 mm.). Known from the vicinity of Davis Gap, Waynesville, and Frying Pan Mountain, North Carolina *marmorata intermedia* p. 224

MOORE'S SALAMANDER. *Leurognathus marmorata marmorata* Moore. Fig. 60. Map 28.

TYPE LOCALITY. Grandfather Mountain, North Carolina.

RANGE. Known from the following counties in western North Carolina: Watauga, Caldwell, Avery, Burke, McDowell, Yancey, Buncombe, Henderson, and Haywood, and from Roan Mountain, Carter County, Tennessee.

HABITAT. An aquatic species found in streams and spring runs, hiding beneath flat stones or boulders in the pools and riffles, or exposed and resting quietly on the bottom. Sometimes found in the open on the

naked rock of stream beds where water flows in a thin sheet or in trickles.

SIZE. The average length of 10 adults of both sexes from the North Carolina mountains is $4\frac{1}{16}$ " (108.5 mm.), the extremes $3\frac{9}{16}$ " (90 mm.)



MAP 28.—Distribution of the subspecies of *Leurognathus marmorata*.

and $5\frac{1}{16}$ " (128 mm.). The proportions of an adult male from Grandfather Mountain, North Carolina, are: total length 4" (101 mm.), tail $1\frac{7}{16}$ " (36 mm.); head length $2\frac{1}{2}$ " (16 mm.), width $1\frac{1}{2}$ " (11 mm.). A female from the same locality: total length $4\frac{1}{16}$ " (103 mm.), tail $1\frac{17}{32}$ " (38 mm.); head length, $2\frac{1}{2}$ " (16 mm.), width $1\frac{3}{8}$ " (10.5

mm.). A large female from near Linville Falls, North Carolina, has a total length of $5\frac{21}{32}$ " (145 mm.).

DESCRIPTION. This species has sometimes been confused with *Desmognathus quadramaculatus* and *D. phoca*. Viewed from above, the head is widest at the back, gently rounding or slightly tapering to the eyes, then more abruptly converging to the bluntly pointed snout. The snout is strongly depressed. The eyes are large, strongly protuberant, and limited behind by an oblique fold. An impressed sinuous line from the posterior angle of the eye to the lateral extension of the gular fold, a short vertical groove from this line passing behind the angle of the mouth. The trunk is somewhat flattened above and provided with an impressed median line; sides rounded. There are usually 13 costal grooves, rarely 14, counting 1 each in the axilla, which may be poorly developed, and 1 in the groin; 3 intercostal spaces between the toes of the appressed limbs. Tail subquadrate in section and flattened at base above, becoming strongly compressed and knife-edged above, about at the end of the proximal third. The tail is rounded below and without a free fin except at the distal fourth. Legs rather short and stout, toes 5-4, those of the hind feet 1-5-2-(4-3) in order of length from the shortest; toes of the fore feet 1-4-2-3; all toes tipped with black, and those of the hind feet slightly webbed at base. The tongue is large and fleshy and fills the floor of the mouth; it is broader than long, attached at the center in front, and with the margins free. Vomerine teeth usually lacking in adults of both sexes, 2 or 3 rarely developed in females. Paraphenoid teeth in 2 slender, elongate patches which taper and meet anteriorly and diverge posteriorly. Inner nares small, widely separated, and concealed in slit-like grooves at the sides of the mouth.

COLOR. In life this species is mottled above with shades of buff and gray that match the stream-bottom background of pebbles and small stones and render the animal inconspicuous until it moves. The light and dark patches alternate more or less regularly so that a broad zigzag pattern is formed, or 2 rows of light blotches with indefinite edges extend from the back of the head well onto the tail. The sides of the trunk

and tail are grayish or brownish with light scattered flecks. The venter may be uniformly and lightly pigmented, or the darker colors of the lower sides may encroach irregularly on the sides of the venter, leaving a fairly light central area. In some individuals the venter may become very dark except for a narrow central spot. The legs are mottled above

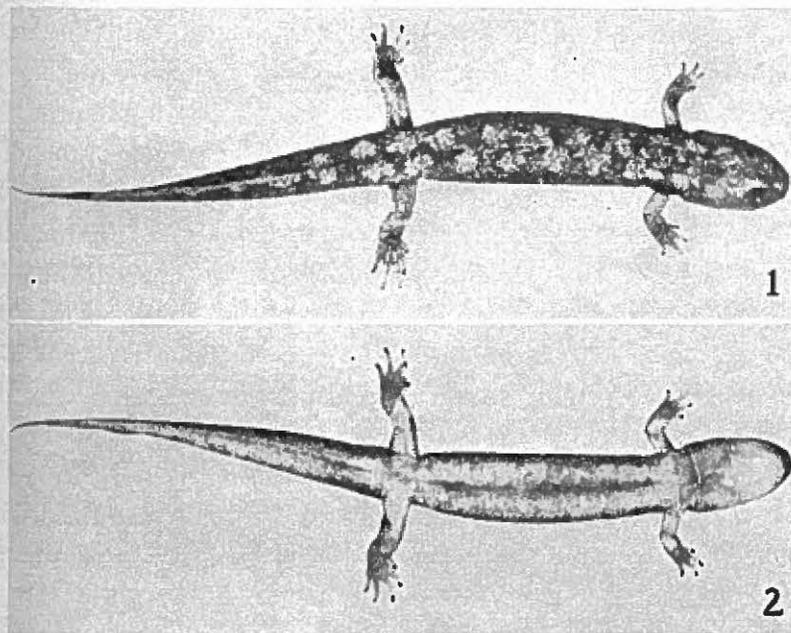


FIG. 60. *Leurognathus marmorata marmorata* Moore. (1) Adult female, actual length $4\frac{7}{16}$ " (112 mm.). (2) Same, ventral view. Yonahlossee Road near Grandfather Mountain, North Carolina.

and on the sides, lightly blotched below. In the majority of specimens the anterior half of the throat, the sides of the vent, and the distal third of the tail below are lighter than surrounding areas. The vent of the male is larger than that of the female and has the margins ridged and grooved. Old individuals may be very dark above and below with only a faint indication of a dorsal pattern.

BREEDING. Dissection of adult females taken in October revealed 26-34 ovarian eggs, each approximately 1.6 mm. in diameter (Bishop, 1924,

p. 95). Nothing was learned of the egg-laying habits until Pope's discovery of a cluster of 28 eggs attached to the edge of a submerged stone in the running water of a small mountain stream. The eggs were grouped together in 2 layers and attached by means of short extensions of the outer envelope (Pope, 1924, p. 13).

LARVAE. Larvae 8-10 days after hatching have a total length of approximately 17 mm. (Pope, *ibid.*, Fig. 2). The larvae have a wide dorsal fin confined to the tail and rising in a broad curve above the line of the back. The gills are long, filamentous, and lacking in pigment, the eyes large. There is a row of small light spots on either side of the mid-dorsal line, and the back and sides are pigmented to the lower level of the legs. Larvae may attain a length of 66 mm. before transformation, and the larger ones may be briefly characterized as follows: The general ground color is light brown (in preservative). On either side of the middorsal line a series of round tan spots extend along the trunk and basal quarter of the tail. The dark pigment extends on the sides of the head to involve the margin of the lower jaw and sides of the throat, on the trunk to the lower level of the legs, and on the tail encroaches narrowly on the ventral surface. The chin is narrowly margined with dusky. The inner nares are longitudinal slits which lie below the anterior end of the eye.

POPE'S SALAMANDER. *Leurognathus marmorata intermedia* Pope. Fig. 61. Map 28.

TYPE LOCALITY. Given as Davis Gap, Waynesville, North Carolina, but apparently from the Davis farm about 2 miles east and a little north of Waynesville, on Highway No. 276.

RANGE. In addition to the type locality, known from the Boone farm $3\frac{1}{2}$ miles southeast of Waynesville and from Frying Pan Mountain, near Mt. Pisgah, at elevations of 4000' and above.

HABITAT. In streams and springs, generally at high elevations. May be found hiding beneath stones or resting quietly at the pool bottoms. Essentially aquatic but occasionally on land.

SIZE. Five adults of both sexes average $4\frac{5}{32}$ " (105.7 mm.) with extremes of $3\frac{1}{16}$ " (94 mm.) and $4\frac{13}{16}$ " (122 mm.). The proportions of an adult female taken Oct. 13, 1926, on Frying Pan Mountain, Haywood County, North Carolina, are as follows: total length $4\frac{13}{16}$ " (122 mm.), tail $2\frac{1}{8}$ " (54 mm.); head length, $1\frac{1}{16}$ " (17 mm.), width $\frac{9}{16}$ " (14 mm.). An adult male from near Waynesville, North Carolina, has the following measurements: total length $4\frac{17}{32}$ " (115 mm.), tail $1\frac{10}{16}$ " (41 mm.); head length $2\frac{1}{32}$ " (16 mm.), width $1\frac{3}{32}$ " (10.5 mm.).

DESCRIPTION. Resembles some juvenile specimens of *Desmognathus quadramaculatus*, but may be distinguished by lack of well developed vomerine teeth and concealed inner nares. Viewed from above, the head is oval in outline, widest just in front of the lateral extensions of the gular fold, the sides curving broadly and evenly to the bluntly pointed and strongly depressed snout. The eyes are large and strongly protuberant, the iris tinged with brassy near the pupil. An oblique fold back of the eye and from this a sinuous line extending to the lateral extension of the gular fold. A short vertical groove crossing the sinuous line and extending to the angle of the mouth. In adults, the trunk somewhat flattened above, and with an impressed median line; the sides well rounded. There are 13 costal grooves, counting 1 in the axilla and 2 that run together in the groin, or 14 when the 2 in the groin remain separated, and $2\frac{1}{2}$ - $3\frac{1}{2}$ intercostal spaces between the toes of the appressed limbs. Tail flattened at base above and subquadrate in section, becoming compressed and sharp-edged and keeled above, beginning about at the end of the proximal fourth; ventral tail fin narrow and limited to the distal fourth. Legs short and stout; toes 5-4, those of the hind feet 1-5-2-(4-3) in order of length from the shortest, webbed at base; toes of the fore feet 1-4-2-3; toe tips usually black. Tongue large, attached medially in front, the side margins free. Vomerine teeth usually lacking in the male, although an occasional individual may develop 1 or 2; vomerine teeth in female variable, usually 1 or 2 on each side, or present on one side and lacking on the other; juveniles sometimes with fairly regular series of 4-4 teeth in slightly curved lines separated by

about the length of a series. Parasphenoid teeth in 2 long slender patches tapering anteriorly where they unite, and narrowly diverging poste-

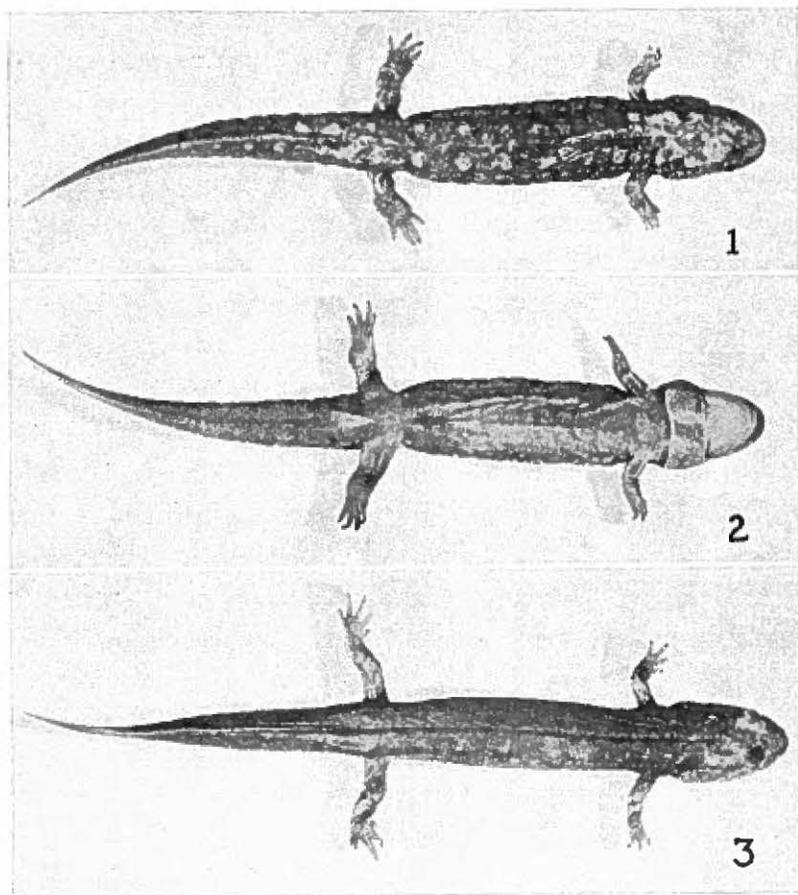


FIG. 61. *Leurognathus marmorata intermedia* Pope. (1) Adult female, actual length $4\frac{1}{16}$ " (120 mm.). (2) Same, ventral view. Frying Pan Mountain, near Big Pisgah, North Carolina. (3) Adult male, actual length $4\frac{3}{32}$ " (104 mm.). Near Waynesville, North Carolina. [Photographs from preserved specimens.]

riorly. Inner nares small and concealed in a groove at the side of the mouth.

COLOR. The color in life is variable, but the pattern is usually constant. In some the ground color above is dark walnut-brown, the sides lighter,

grayish-brown. On each side above, a dorsolateral series of round light spots, well separated, extending from the head back of the eyes onto the basal half of the tail. The legs are lighter than the back and lightly mottled with yellow; upper margin of dorsal tail fin frequently lighter than sides. The venter may be much lighter than the back, speckled with small light yellow spots, or uniformly dark gray, nearly black, flecked with small light spots. The throat is lighter than the belly, although often lightly mottled, flesh-colored in the central area, and whitish on the chin. Tail beneath, colored like the belly at base, fading to yellowish toward the tip. On some individuals there are 2 secondary rows of small light spots on the sides, the upper extending from the eye well onto the tail, the lower forming a broken line between the limbs. In some dark specimens, a light line from the eye to the angle of the jaw. The vent of the male has a free flange-like margin and the sides within are covered by papillae. The vent of the female has the margins crossed by grooves and ridges but lacks the papillae. The tip of the lower jaw of the male pointed, that of the female evenly rounded.

BREEDING. Nothing has been published on the breeding habits of this species. The large female taken on Frying Pan Mountain, North Carolina, October 13, 1926, has large ovarian eggs apparently nearly ready to be deposited.

LARVAE. I have not found a published description of the larva. A single specimen from the type locality in my own collection is $1\frac{3}{4}$ " (45 mm.) in total length. It is uniformly Mummy Brown (Ridgway) above, very light, probably flesh color in life, below. Scattered generally over the surface of the head, back, and sides are many small, separate, black chromatophores, and dorsally a few scattered, rounded pigment-free spots. On the upper sides and ventrolaterally these light spots tend to form indistinct lines between the legs. The pigment of the lower sides encroaches on the sides of the throat, the sides of the belly and nearly to the mid-line of the venter of the tail. The gills are short and pigmented only at the base. The dorsal tail fin arises at a point opposite the posterior end of the vent and reaches its greatest width about mid-

way the length of the tail. The ventral fin is narrower and confined to the distal half. The inner nares of the larva, as in the adult, are slit-like and lateral in position. The smallest fully transformed individual in my collection has a total length of $2\frac{7}{16}$ " (62 mm.).

GENUS PLETHODON

KEY TO THE SPECIES AND SUBSPECIES OF PLETHODON

Several species of *Plethodon* have distinctly different color phases, and most species undergo conspicuous changes of color in preservatives. To aid in the identification of both living and preserved material, a species may appear more than once in the key.

1. With a median, dorsal band having definite edges 2
Without a median dorsal band; or, if markings form a band, then not with definite edges 13
2. Dorsal band gray, red, brown, or chestnut 3
Dorsal band dull white, tan, yellow, or greenish-yellow 9
3. Dorsal band with zigzag margins; dorsal band red or red suffused with dusky (fades to dull red or yellow in preservatives); venter lighter than back, mottled; usually 17 costal grooves, occasionally 16 or 18; length to $3\frac{1}{2}$ " (89 mm.). From western Pennsylvania and southern Ohio south through Kentucky and Tennessee to Alabama *cinereus dorsalis* p. 236
Dorsal band with margins straight or slightly irregular but never definitely zigzag 4
4. Costal grooves 16 or less 5
Costal grooves 17 or more 7
5. Intercostal folds between toes of appressed limbs 3 or less 6
Intercostal folds between toes of appressed limbs 5 or more; dorsal band red in various shades to red strongly suffused with dusky; if dorsal band indistinct, then its margins indicated by a narrow light line on each side; venter light, mottled; usually 15 costal grooves, occasionally 16; length to $4\frac{1}{8}$ " (105 mm.). Western Oregon, Washington, and British Columbia *vehiculum* p. 278
6. Belly and throat lightly pigmented and sometimes blotched, lighter than back; median dorsal band chestnut-red; costal grooves usually 15, occasionally 16; intercostal folds between toes of appressed limbs, 0-1; length to $6\frac{1}{2}$ " (165 mm.). Blue Ridge Mountains in western North Carolina and southwestern Virginia *yonahlossee* p. 287
Belly as dark as back, throat light; above chestnut-brown overlying a darker ground color, with small brassy or golden flecks; upper sides chestnut varied with black; lower sides with a broad whitish band

- with irregular upper edge; costal grooves usually 16, 15 to 17; intercostal folds between toes of appressed limbs, 1-3; length to $4\frac{3}{4}$ " (121 mm.). Oklahoma and Arkansas *ouachitae* p. 269
7. Costal grooves 20-23; dorsal band narrow, poorly developed, scarcely lighter than adjacent sides; dorsal surfaces with minute silvery-white and bronze flecks; belly dark, throat somewhat lighter, mottled; costal grooves usually 21, occasionally 20 to 23; intercostal folds between toes of appressed limbs, 9-10; length to $5\frac{3}{8}$ " (130 mm.). Pennsylvania, West Virginia, Kentucky, and southeastern Ohio *richmondi* p. 272
Costal grooves 17-19 8
 8. Parasphenoid teeth in a single patch notched behind; dorsal band brown or chestnut strongly suffused with dusky; upper sides dark, lower sides slate, often with minute whitish flecks; belly slate, throat lighter, mottled; usually 17 costal grooves, occasionally 18; intercostal folds between toes of appressed limbs 6-7; length to $5\frac{1}{8}$ " (131 mm.). Extreme northwestern California and southwestern Oregon *elongatus* p. 246
Parasphenoid teeth in 2 patches; dorsal band usually some shade of red, occasionally gray, often with flecks of black; sides gray or black; belly mottled, pepper-and-salt; 18-20 costal grooves; intercostal folds between toes of appressed limbs, 7-9; length to $3\frac{9}{16}$ " (91 mm.). Southeastern Canada south to Texas, Georgia, Missouri, and Arkansas *cinereus cinereus* p. 232
 9. Belly very light, flesh to yellow, sometimes faintly suffused with dusky; adults with parotoid glands; sides uniformly light brown; dorsal stripe yellow or tan; 13-14 costal grooves; 2-3 intercostal folds between toes of appressed limbs; length to $4\frac{1}{3}$ " (116 mm.). Western Washington *vandykei* p. 275
Belly pigmented; adults without parotoid glands 10
 10. Costal grooves 18 or more; dorsal stripe tan or dull yellow; other characters as above under 8 *cinereus cinereus* p. 232
Costal grooves 16 or less 11
 11. Costal grooves 13-14; belly black; 3 intercostal folds between toes of appressed limbs; dorsal stripe yellow, strongly suffused with brown on the head and tail tip; sides black with scattered gray flecks; length to 4" (101.5 mm.). Kootenai County, Idaho *idahoensis* p. 259
Costal grooves 15 or 16; belly light, mottled 12
 12. Intercostal folds between toes of appressed limbs, about 4; dorsal band dull tan to yellowish-green; upper sides brown with many dull white and tan flecks and dashes; venter pale slate with many pale spots, whitish or yellowish; costal grooves usually 15, occasionally 16, rarely 14; vomerine teeth 8-13, rarely fewer; length to $5\frac{1}{8}$ " (131 mm.). Southwestern Oregon to southwestern Washington *dunni* p. 242
Intercostal folds between toes of appressed limbs 5 or more; dorsal band

- yellow or dull white (rarely living specimens and most preserved specimens on which the red has faded); other characters as above under 5; hind feet sparsely webbed *vehiculum* p. 278
13. With red spots, flecks, or patches present 14
Without red spots, flecks, or patches 15
14. Black above, with red spots or flecks on dorsal surface of legs (color fades to white or yellow in preservatives); lower sides light gray; belly light, bluish-white or pale gray; throat light; costal grooves 15-16; 1-2 intercostal folds between toes of appressed limbs; length to 6" (153 mm.). Southwestern North Carolina
..... *glutinosus shermani* p. 253
Black above, with a red patch on side of head (fades to white or yellowish in preservatives); lower sides and belly dull bluish-gray; throat anteriorly flesh color; costal grooves 15-16; 2-3 intercostal folds between toes of appressed limbs; length to 5 $\frac{9}{32}$ " (135 mm.). Great Smoky Mountains in western North Carolina and eastern Tennessee
..... *jordani* p. 261
15. Uniformly dark gray or black above and on upper sides; no conspicuous spots, flecks, or other markings 16
Not uniformly dark gray or black above and on sides 24
16. Costal grooves 16 or less 17
Costal grooves 17 or more 20
17. Intercostal folds between toes of appressed limbs, 2 or less; bluish-brown to purplish-gray above; belly dull grayish; throat grayish-white; usually 16 costal grooves, occasionally 15; length to 6 $\frac{1}{8}$ " (156 mm.). Southwestern Virginia through western North Carolina, northern South Carolina, northern Georgia, Roan Mountain, Tennessee, and possibly northeastern Alabama *metcalfi* p. 264
Intercostal folds between toes of appressed limbs 3 or more 18
18. Belly strongly mottled; basal segments of legs above usually with some light spots; dorsal band lacking or indicated only by narrow light lines laterally; other characters as above under 5 (dark phase)
..... *vehiculum* p. 278
Belly uniformly colored; basal segments of legs above without light spots 19
19. Costal grooves 14-15; vomerine teeth 6-10, average 8; brown above, venter uniformly pigmented; throat lighter than belly; length to 3 $\frac{1}{16}$ " (94 mm.). New Mexico *hardii* p. 256
Costal grooves 16; vomerine teeth 4-6, average 5; uniformly slate above; belly grayish-blue, lighter than back, uniformly pigmented or rarely slightly blotched and with a few light flecks anteriorly; under surface of legs frequently with a light mark at joint; length to 3 $\frac{1}{16}$ " (78 mm.). Grandfather Mountain, North Carolina, and Whitetop Mountain, Virginia (preserved specimens) *welleri* p. 285
20. Belly much lighter than back, mottled yellow and gray 21

- Belly dark, with few or no light flecks 22
21. Costal grooves 18-19, occasionally 20; uniformly dark brown or lead-colored above; lower sides, throat, and belly light, mottled; other characters as above under 8 (lead-backed phase)
..... *cinereus cinereus* p. 232
Costal grooves usually 17, occasionally 16 or 18; uniformly brown or lead-colored above; vomerine teeth 4-6; other characters as above under 3 (dark phase) *cinereus dorsalis* p. 236
22. With 20-23 costal grooves; ground color uniformly dark above; belly dark, throat lighter, mottled; other characters as above under 7 (preserved specimens) *richmondi* p. 272
With 17-19 costal grooves 23
23. Usually with parasphenoid teeth in a single patch; 6-7 intercostal folds between toes of appressed limbs; other characters as above under 8 (dark phase) *elongatus* p. 246
With parasphenoid teeth in 2 patches; 5-6 intercostal folds between toes of appressed limbs; uniformly bluish-black above; venter slightly lighter and often with a few whitish flecks along sides of belly; throat lighter; costal grooves usually 18, 17 to 19; 5-6 intercostal folds between toes of appressed limbs; length to 3 $\frac{1}{8}$ " (90 mm.); West Virginia (preserved specimens) *nettingi* p. 266
24. Dark gray or black above, with white or pale bluish-white spots or blotches on sides and sometimes on back; or, with light gray lichen-like patches on sides and often on back 25
Without silvery-white, bluish-white, or lichen-like gray patches on sides, but with small silvery, bronze, or golden flecks on back 29
25. Light markings forming lichen-like blotches on back and often on sides; belly and ventral surface of tail black; throat whitish; 15 costal grooves; 1-2 intercostal folds between toes of appressed limbs; iris deep brown without brassy flecks; length to 5 $\frac{1}{16}$ " (149 mm.). Vicinity of Jocassee, South Carolina *clemsonae* p. 239
Light markings not forming lichen-like patches, often in separate spots but sometimes fused to form irregular bands on lower sides 26
26. Entire ventral surface dark slate-color in life, blue-black in preserved specimens; light markings on sides, occasionally on back, silvery-white; usually 16 costal grooves; intercostal folds between toes of appressed limbs, 1-3; vomerine series long, 10-13; length to 7 $\frac{7}{16}$ " (188 mm.). New York westward to Wisconsin, southward to northern Florida, westward to Texas and Missouri *g. glutinosus* p. 250
Entire ventral surface not dark 27
27. Belly dark, throat light 28
Belly and throat lightly pigmented and sometimes blotched, definitely lighter than back; lower sides with small white spots; costal grooves usually 15; other characters as above under 6 (preserved specimens)
..... *yonahlossee* p. 287

28. Parasphenoid teeth in a single broad patch; a few whitish flecks and faded blotches on sides; often with faded whitish spots or blotches on tail, above; vomerine teeth 7-13; other characters as above under 6 (preserved specimens) *ouachitae* p. 269
- Parasphenoid teeth in 2 patches; ground color above bluish-black; belly and ventral surface of tail grayish; throat light; light spots small, white to bluish-white, usually restricted to lower sides; costal grooves usually 16, occasionally 17; 2 or 3 intercostal spaces between toes of appressed limbs; vomerine teeth 6-9; length to 6" (152 mm.). Southwestern New York, Pennsylvania, West Virginia, and southeastern Ohio *wehrlei* p. 281
29. Costal grooves 20-23; intercostal folds between toes of appressed limbs, 9-10; brown above on the trunk, with many small silver-white and bronze flecks; lower sides and venter with small light spots; other characters as above under 7 (dark phase) *richmondi* p. 272
- Costal grooves 19 or less 30
30. Costal grooves 16; 3-4 intercostal grooves between toes of appressed limbs; ground color above black, with many small dull golden blotches on the back and a few golden flecks on upper sides; sides mostly black, with a few whitish flecks near belly; belly slate, sometimes with a few scattered light spots; throat light, venter of tail darker; length to 3 1/16" (78 mm.); Grandfather Mountain, North Carolina, and Whitetop Mountain, Virginia (living) *welleri* p. 285
- Costal grooves 17-19; above deep brown, almost black, with many fine, pale-brassy flecks over dorsal surfaces and upper sides of head and trunk; belly and ventral surface of tail dark slate; throat lighter; other characters as above under 23 (living) *nettingi* p. 266

EASTERN RED-BACKED SALAMANDER. LEAD-BACKED SALAMANDER. *Plethodon cinereus cinereus* (Green). Figs. 1b, 62. Map 29.

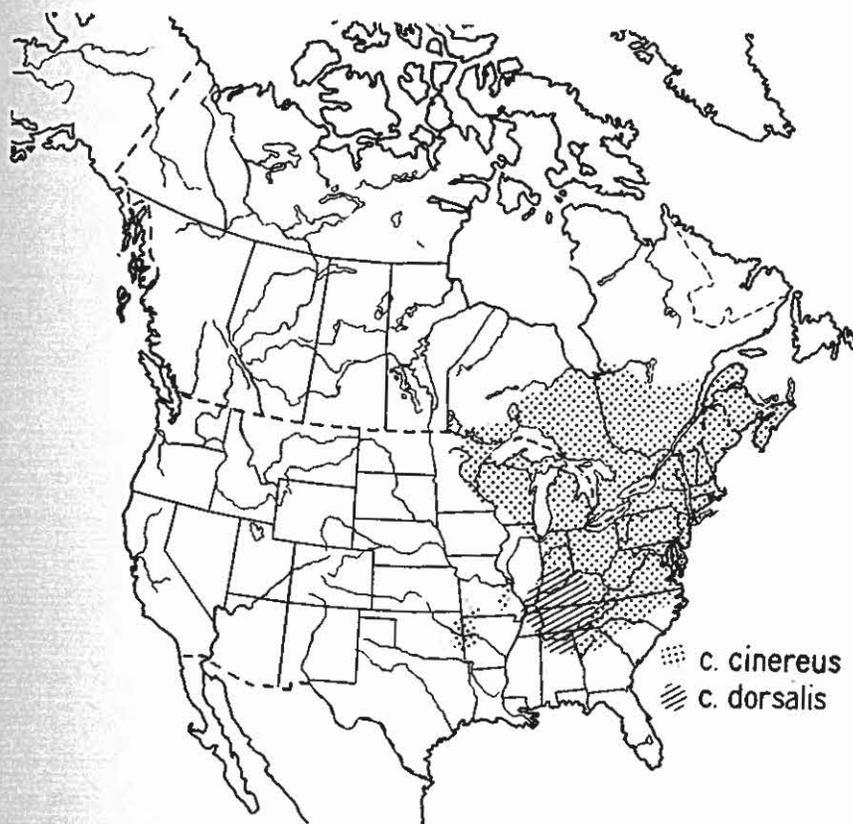
TYPE LOCALITY. New Jersey.

RANGE. Gaspesia and Cape Breton Island west to Fort William, Ontario, south to Dallas, Georgia, Missouri, and Arkansas (Stejneger and Barbour, 1939, p. 13).

HABITAT. The Red-backed salamander is completely adapted to terrestrial life and is abundant beneath old logs, bark, moss, leaf mold, and stones, in evergreen, mixed, and deciduous forests. May be found in fairly dry situations but is most abundant where there is indication of moisture.

SIZE. Reaches an extreme length of 122 mm. (Davis, 1942, p. 258).

The males are a little smaller than the females, the adults ranging from 2 5/16" to 3 5/8" (58-91 mm.) and averaging about 2 3/4" (73 mm.). The females average 3 1/8" (78 mm.) and vary from 2 1/2 to 3 9/16" (64-90 mm.). In a series of specimens from Big Babson's Island, Maine, in the



MAP 29.—Distribution of the subspecies of *Plethodon cinereus*.

U. S. National Museum, there are individuals varying from 84 to 115 mm. in total length.

DESCRIPTION. The body is long and fairly slender, slightly flattened dorsally, and well rounded on the sides. The tail is nearly circular in section throughout its length. There are usually 18 or 19 costal grooves but the number may vary from 17 to 20. The gular fold is prominent.

The legs are small, the toes short and thick, those of the fore feet 1-4-2-3 in order of length; hind toes rather thick and fleshy, slightly webbed at base, 1-5-2-4-3 in order of length. The mouth is fairly large, with the angle of the jaws back of the eye. The small tongue does not fill the floor of the mouth. The vomerine series form 2 backward-curving lines of 5-7 teeth separated from each other and from the parasphenoid teeth, which are in 2 imperfectly separated patches.

COLOR. There are 2 distinct color phases, and individuals are encountered of an intermediate character. The red-backed phase is characterized by the possession of a broad, median, dorsal band that originates on the head and extends along the trunk and onto the tail. The dorsal stripe varies in color from light gray and dull yellow through shades of pink, brick-red to bright red, often with small flecks of black within the band. Below the dorsal band the sides are dark gray or black, becoming lighter and mottled toward the belly. The belly is strongly mottled with gray and white. In the lead-backed phase, the color above is uniformly dark gray to almost black, with the head and legs usually lighter. In some localities the color phases are about equally represented, in others one or the other phase may predominate.

SEXUAL DIFFERENCES. The male differs from the female in its more swollen snout, in having enlarged premaxillary teeth, and in having the legs proportionally longer. In body length the male is usually shorter.

BREEDING. There is a rather extended mating season in the fall, October to December, during which spermatophores are deposited by the male and recovered by the female. The egg-laying season extends from June through July, in the North. The eggs are deposited in little clusters, containing usually 8-10 but varying from 3 to 13, held together like a bunch of grapes and suspended by a common pedicel to the roof of the cavity chosen for the nest. Usually the eggs are found in well rotted logs, rarely in little cavities on the lower surface of stones, and attended by the female. The individual egg varies in size from 3.5 to 5 mm., depending somewhat on the amount of moisture present, and in addition to the vitelline membrane has 2 distinct envelopes. The outer envelope

usually is covered by whitish mucous strands that converge to form the attachment stalk. The length of the period of incubation in the field

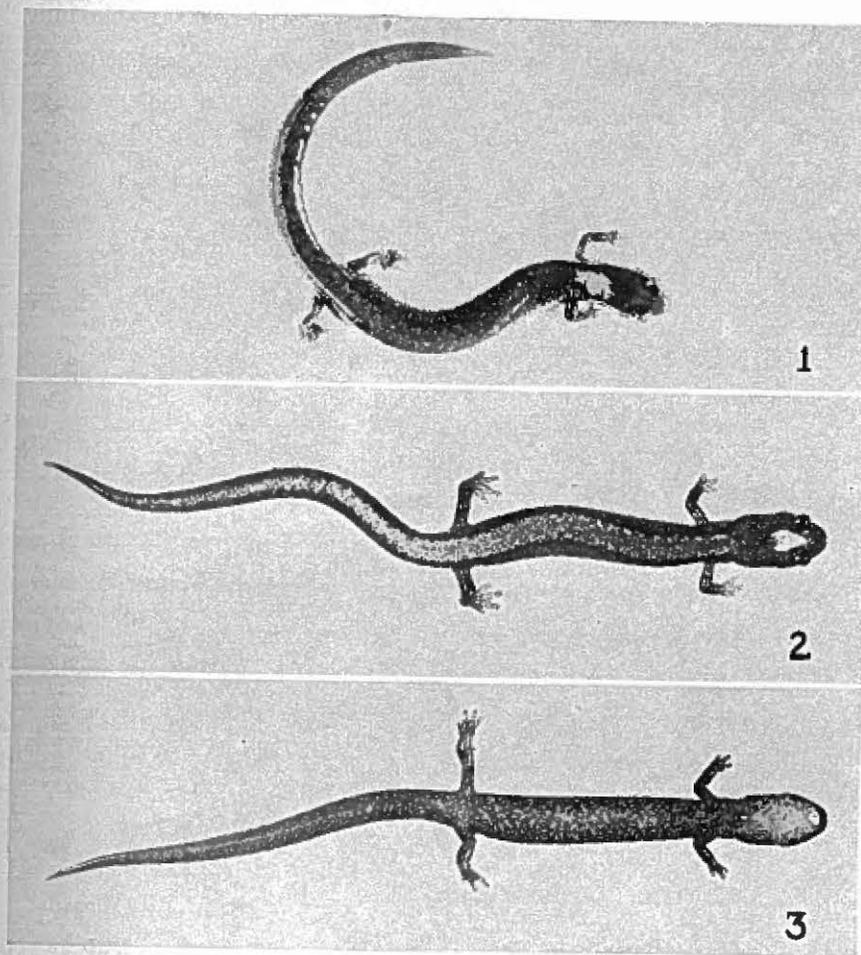


FIG. 62. *Plethodon cinereus cinereus* (Green). (1) Adult, about natural size. Kenwood, Albany County, New York. (2) Adult female, red-backed phase; actual length $2\frac{29}{48}$ " (74 mm.). (3) Same, ventral view. Rochester, New York.

has never been accurately determined, but recently hatched young may be found all through August.

LARVAE. The recently hatched larvae average about $\frac{3}{4}$ " (19 mm.) in

length. In the red-backed phase, the dorsal band is well developed at the time of hatching and the upper sides are strongly pigmented. The broad, flat, leaf-like gills rise from a common base and often reach their full development before the larva escapes from the egg envelopes. The gills persist only a few days, and the larva develops without entering the water. The toes of both the hind and fore feet are well indicated, the inner and outer short. The young are well endowed with yolk, and on this they are sustained until able to shift for themselves. Sexual maturity is attained at an age of about 2 years.

ZIG-ZAG SALAMANDER. *Plethodon cinereus dorsalis* (Cope). Fig. 63. Map 29.

TYPE LOCALITY. Louisville, Kentucky.

RANGE. Southern Ohio, southern Indiana, southeastern Illinois, central Kentucky, Tennessee, and northern Alabama.

HABITAT. Found beneath logs and stones in woods, also in and about the mouths of caves. Common under stones, logs, and bark in the clearings at the foot of the Smoky Mountains at Elkmont, Tennessee. Blanchard (1925, p. 368) took a series of specimens under leaves and logs in a small, damp, wooded ravine near the flood-plain of the Ohio River in Henderson County, Kentucky, June 15.

SIZE. The largest specimen, a male, measured by Dunn (1926, p. 160) had a total length of $3\frac{7}{16}$ " (87 mm.), tail $1\frac{5}{8}$ " (41 mm.). The proportions of a male from Woodford County, Kentucky, are as follows: total length $3\frac{9}{32}$ " (83 mm.), tail $1\frac{17}{32}$ " (39 mm.); head length, $\frac{3}{8}$ " (10 mm.), width $\frac{7}{32}$ " (5.5 mm.). A female from the same locality measures: total length $3\frac{1}{4}$ " (82 mm.), tail $1\frac{15}{32}$ " (37 mm.); head measurements like those of male.

DESCRIPTION. This species is smaller and more slender than its near relative, *Plethodon c. cinereus*. The head is slender, the sides behind the eyes slightly converging to the lateral extensions of the gular fold; snout short and bluntly pointed. Eyes strongly protuberant and relatively large. A sinuous groove from the posterior corner of the eye to the lat-

eral extension of the gular fold; a short vertical groove from this to the angle of the jaw. Trunk slender, the sides well rounded, back and belly slightly flattened; back with a median depressed line from back of head onto basal third of tail. Tail nearly circular in cross section near base, gradually tapering to a slender tip. Costal grooves usually 17, counting

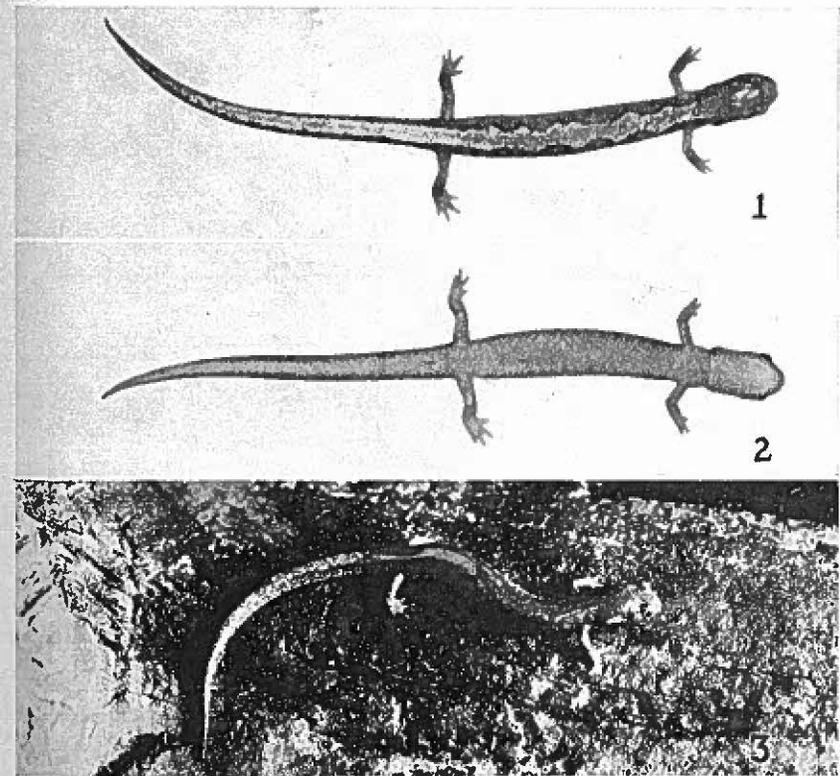


FIG. 63. *Plethodon cinereus dorsalis* Cope. (1) Adult female, actual length $3\frac{7}{16}$ " (81 mm.). (2) Same, ventral view. (3) Same, from life. Woodford County, Kentucky.

1 each in axilla and groin, rarely 16, less rarely 18; 6-7 costal folds between toes of appressed limbs. Legs slender but well developed; toes 5-4, those of hind feet 1-5-2-3-4 or 4-3 in order of length from the shortest; fore feet 1-4-2-3, the innermost rudimentary; all toes slightly webbed at base. Tongue large, filling floor of mouth, the margins thin

and smooth. Vomerine teeth 5 or 6, in 2 short series beginning behind inner nares and curving gently inward and backward, separated by the width of a naris. Parasphenoid teeth in 2 closely approximated club-shaped patches, separated from the vomerine by about the length of a vomerine series.

COLOR. The pattern above consists of a zigzag band extending from the back of the head to the base of the tail, and usually of some shade of red. It is limited each side by a narrow dark line. The upper sides are brownish or reddish with small bluish-white points which give a shade only slightly darker than the dorsal band. In some, the sides may be quite uniformly grayish-white. The zigzag band may extend the entire length of the trunk and be sharply set off, or the zigzags may be limited to the anterior half of the trunk, the remaining part having straight sides. In some specimens the general color of the upper sides may be continued across the dorsum, to the almost complete obliteration of the dorsal band. In a few individuals, the dorsal band may have the sides straight, but in these the band is narrower than in specimens of *P. cinereus* of the same size. On the dorsal surface of the tail the band usually has straight sides; it may continue to the tip in light-colored individuals, or fade out on the basal third in dark specimens, the tip being silvery-gray. This species has a dark phase suggestive of that of *P. cinereus* but differing somewhat in color. Several specimens from Kentucky are dark reddish-brown above, fading on the sides to the mottled belly. The belly has a ground color bluish-white in life but changing to dull yellow in preservatives. It is strongly mottled with clusters of grayish chromatophores. The throat is usually lighter and there is a light area, sometimes red, on the sides of the trunk in front of each fore leg. The legs are colored above like the sides of the trunk, below like the venter.

SEXUAL DIFFERENCES. There are no well marked sexual differences. The tip of the lower jaw is slightly more pointed in the male, and the vent may have the sides thrown into inconspicuous ridges.

BREEDING. Little is known of the breeding habits of this species. Fe-

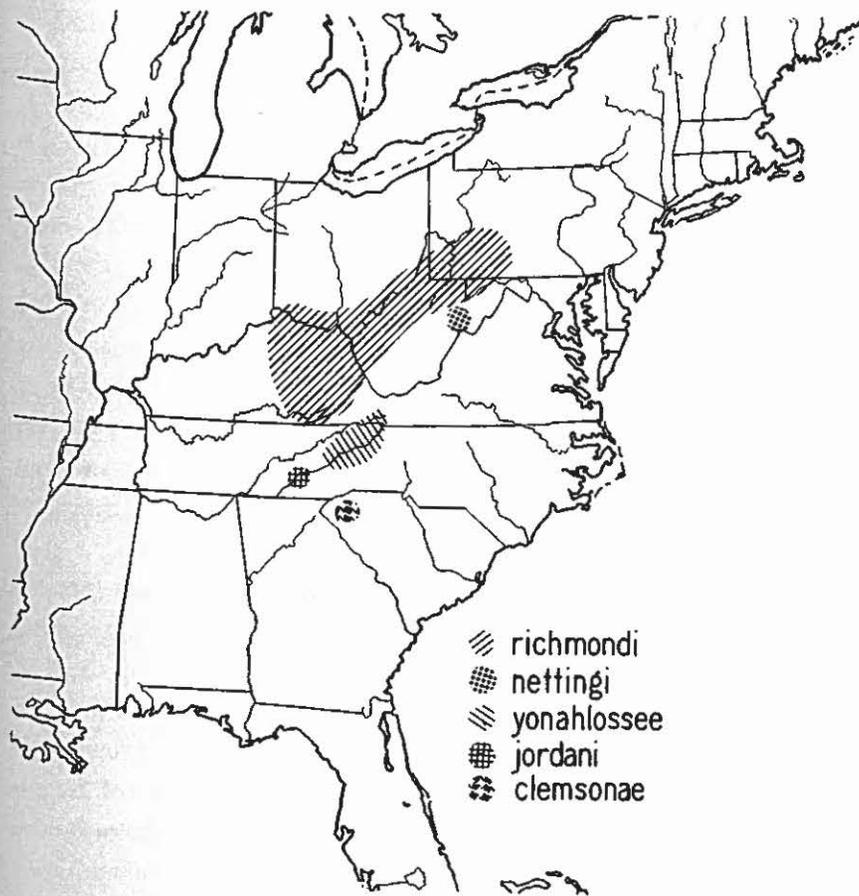
males taken April 24 in Woodford County, Kentucky, had a few ovarian eggs 1 mm. in diameter and many small ones. The larvae have not been described.

FROSTED SALAMANDER. *Plethodon clemsonae* Brimley. Fig. 64. Map 30.

TYPE LOCALITY. Jocassee, South Carolina.

RANGE. Known from the vicinity of Jocassee, South Carolina.

HABITAT. The type and several paratypes were taken at an elevation of



MAP 30.—Distribution of *Plethodon richmondi*, *P. nettingi*, *P. yonahlossee*, *P. jordani*, and *P. clemsonae*.

1200' to 1500' under logs in woods. On April 8, 1941, Arnold B. Grobman and M. B. Mittleman, collecting in the vicinity of the type locality, took 2 adults under logs on a heavily wooded slope.

SIZE. The largest specimen recorded, a male, has a total length of $5\frac{13}{16}$ " (149 mm.); tail $3\frac{3}{8}$ " (80 mm.). An adult female has the following proportions: total length $5\frac{9}{16}$ " (142 mm.), tail $2\frac{23}{32}$ " (69 mm.); head length $2\frac{5}{32}$ " (20 mm.), width $1\frac{15}{32}$ " (12 mm.).

DESCRIPTION. This species has the general proportions of *Plethodon metcalfi* but differs in its larger size and in color and pattern. The head is widest immediately behind the eyes, the sides gently converging to the lateral extensions of the gular fold and in front abruptly to the bluntly rounded snout. The eyes are large and strongly protuberant, about $1\frac{1}{4}$ in the snout; iris deep brown without brassy flecks. A deep sinuous groove from the posterior angle of the eye to the lateral extension of the gular fold; a short vertical groove from this line to the angle of the jaw. Trunk rounded above and on the sides and with a slightly impressed median dorsal line, best developed above the fore and hind legs. There are 15 costal grooves, counting 1 each in the axilla and groin, and 1-2 intercostal folds between the toes of the appressed limbs. Tail long, slender, nearly circular in section throughout its length, and comprising 47.46-53.69 per cent of the total length in the series measured. Legs stout, toes 5-4, those of the hind feet slightly webbed at base, 1-5-2-3-4 in order of length from the shortest; toes of the fore feet 1-4-2-3. Tongue large, nearly filling the floor of the mouth, free at the sides and behind, the narrow plicae parallel but not reaching the front margin. Vomerine teeth in series of 9-12, which arise behind the outer margin of the inner naris and extend inward and backward toward the mid-line, where they are separated by about the diameter of a naris. Parasphenoid teeth in 2 long patches narrowly separated from each other and from the vomerine by about twice the diameter of a naris.

COLOR. The general ground color above is black. Scattered over the dorsal surfaces of the head, trunk, legs, and basal part of the tail are many large, irregular, light gray, lichen-like patches which give these

surfaces a frosted appearance. The light patches are somewhat concentrated along the sides of the head and in some individuals along the sides of the trunk. On the head, and at the base of the tail, the patches may be very lightly tinged with brassy. The throat is evenly and lightly

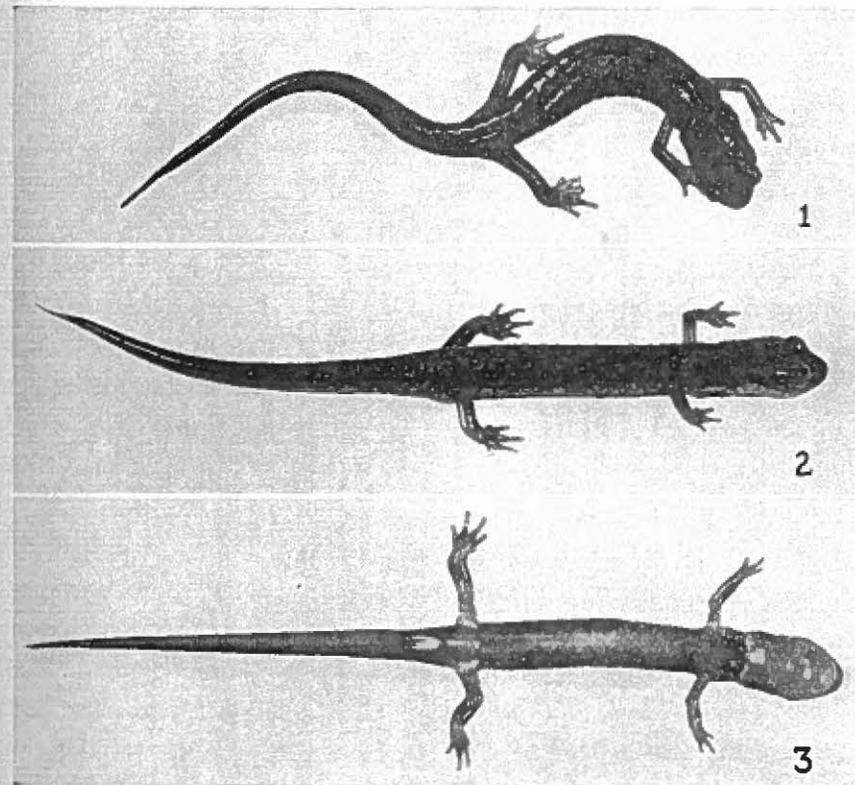


FIG. 64. *Plethodon clemsonae* Brimley. (1) Adult female, actual length $5\frac{9}{16}$ " (136 mm.). (2) Same, dorsolateral view. (3) Same, ventral view. Jocassee, South Carolina.

pigmented so that the general effect is whitish. The belly and ventral surface of the tail black. The feet brownish. This species is easily distinguished from *P. glutinosus*, which is found in the same region, by the diffuse character of the light markings which are distributed abundantly over the dorsal surfaces, by the lighter throat, and by the fewer costal grooves.

BREEDING. Nothing is known of the breeding habits of this species and the eggs and larvae have not been described. In preservatives, the light markings largely disappear, and it is likely for this reason that the species was mistakenly relegated to the synonymy of *P. metcalfi*.

DUNN'S SALAMANDER. WESTERN TAN-BACKED SALAMANDER. *Plethodon dunni* Bishop. Fig. 65. Map 31.

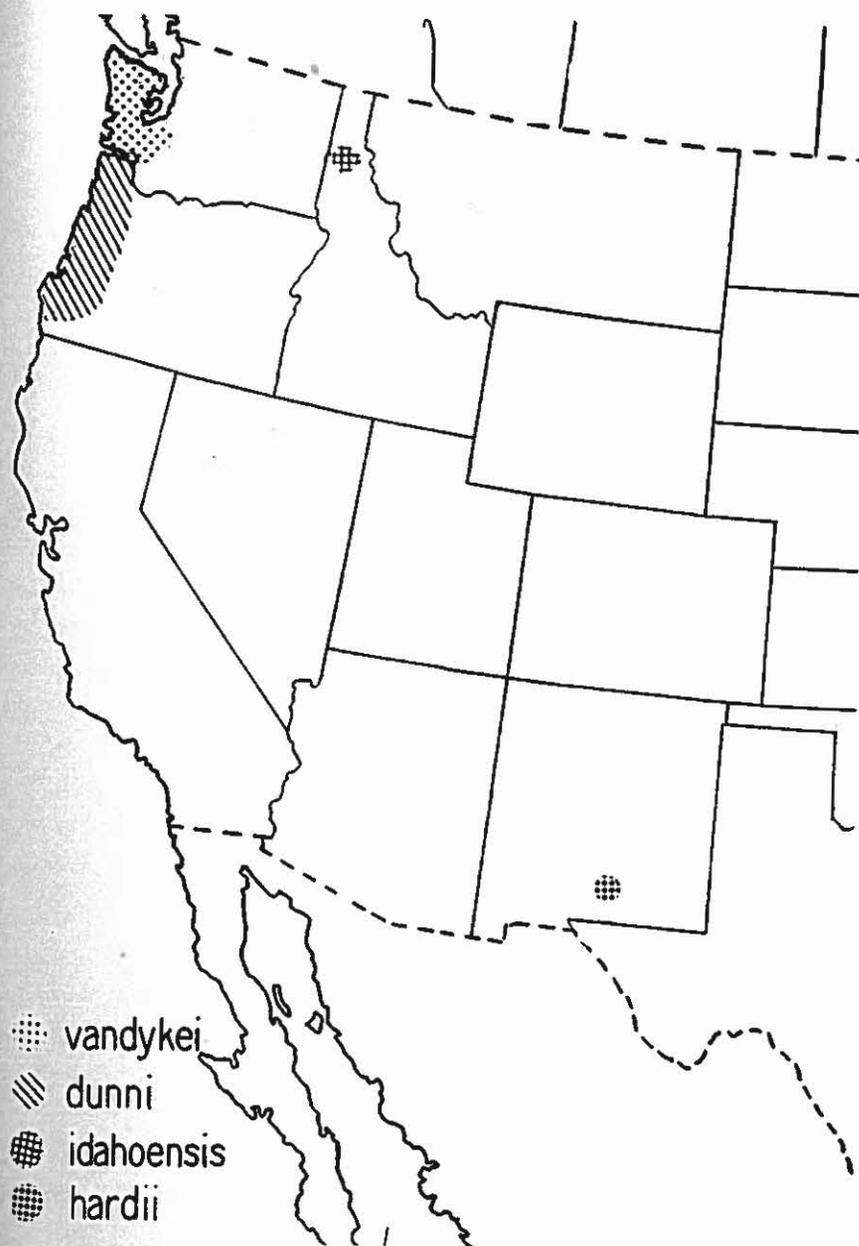
TYPE LOCALITY. Near Portland, Oregon, in Clackamas County.

RANGE. West of the Cascade Mountains from Curry County, southwestern Oregon, to Wahkiakum and Cowlitz Counties, Washington.

HABITAT. On June 13, 1936, we collected at the type locality with Stanley G. Jewett, Jr. Here the salamanders were found beneath logs and bark and among fragments of rock on the sides of a deeply wooded, damp ravine. At Eagle Creek, near Estacada, Oregon, we took additional specimens from beneath fragments of shale on a clay bank bordering the stream. Fitch (1936, p. 637), collecting in a ravine on the north side of Rogue River, 11 miles above its mouth, dug 20 specimens from a rock slide.

SIZE. The adults attain a length of at least 131 mm. The proportions of the type specimen, a female, are as follows: total length, 131 mm., tail, 64.5 mm.; head length, 14 mm. An adult male 97 mm. long has the tail 56 mm. A female of the same length has the tail only 47 mm. long.

DESCRIPTION. *Plethodon dunni* is one of the larger species. The head in the female is moderately wide and with the sides converging only slightly behind. In the male, the head is distinctly widened above the angle of the jaws. The eyes are large and prominent and with the iris tinged with brassy. The trunk is roughly cylindrical, slightly flattened above and more strongly below. The tail is oval in cross section near the base but more strongly compressed distally. The costal grooves normally number 15 on each side, counting 1 each in the axilla and groin, but vary from 14 to 16. The legs are well developed and strong, the hind considerably larger than the fore. Toes 5-4, those of the hind feet 1-5-2-4-3 in order of length from the shortest; toes of the fore feet



MAP 31.—Distribution of *Plethodon vandykei*, *P. dunni*, *P. idahoensis*, and *P. hardii*.

1-4-2-3. Tongue oval, moderately large, and with narrow plicae extending forward from the posterior field. Vomerine teeth in female in series of 8-13. The series originate behind the middle of the inner nares, curve inward and backward, separated posteriorly by about the diameter of an inner nares, and from the parasphenoids by a little more. Parasphenoid teeth in 2 elongate patches, wider behind than before, and narrowly separated throughout their length. In the male the vomerine teeth number 6-8 in each series.

COLOR. In life the ground color is best developed on the upper sides. Here the color is deep brown, fading to pale slate toward the belly. The broad dorsal light band extends from the end of the snout almost to the tip of the tail. It widens on the head back of the eyes, narrows on the neck, maintains its width to the base of the tail, then gradually tapers toward the tip. The dorsal band varies in color from dull tan to yellowish-green in different individuals and is flecked by irregular spots of brown or black. The dark flecks are fewer on the base of the tail above, so that here the band is brighter. The sides are mottled with irregular, dull, white and tan markings. The throat, belly, and lower surfaces of the tail and limbs are slate color, flecked with many small pale spots. In some individuals the pale fleckings are so numerous on the belly that this region appears more yellow than slate. The legs in adults are mottled above with tan and dark brown; in the young frequently yellowish-green, mottled with dusky.

SEXUAL DIFFERENCES. The sexual differences may be emphasized. The head of the male usually widens abruptly back of the eyes, the vomerine series are shorter, and the tail is proportionally longer. The tail in the female comprises 46.1-49.2 per cent of the total length, and in the male 49.1-57.7 per cent.

BREEDING. Little is known of the breeding habits. Slater (1939, p. 154) dissected a female 130 mm. long, taken May 1, 1937, at Portland, Oregon, and found 18 light-cream-colored eggs about 2 mm. in diameter and many smaller ones. Females taken June 1936, across the Willamette River from Portland, had ovarian eggs about 1.5 mm. in diameter. Six

juvenile specimens taken at this time resemble the adults in color and pattern. They are nearly uniform in size, varying only from 40 to 42 mm. in total length.

There is a strong superficial resemblance between certain specimens of *Plethodon dunni* and tan-backed individuals of *Plethodon vehiculum*. The greater number of vomerine teeth, more strongly compressed tail, and more strongly mottled sides of *P. dunni* will distinguish it. The

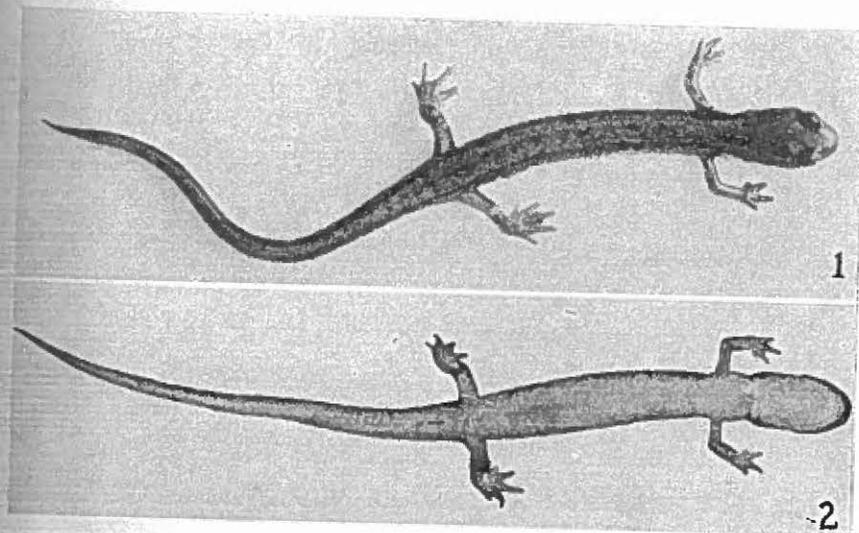


FIG. 65. *Plethodon dunni* Bishop. (1) Adult female, actual length $5\frac{1}{8}$ " (130 mm.). Eagle Creek, Clackamas County, Oregon. (2) Adult male, ventral view; actual length $4\frac{1}{16}$ " (113 mm.). Tidewater, Oregon.

mottling of the upper sides in *P. dunni* extends to the light dorsal band, the edges of which are somewhat irregular. In *P. vehiculum*, the upper sides next to the dorsal band are darker and less mottled, and the band itself has more regular edges. From *P. elongatus*, this species differs in its generally larger size, and in having fewer costal grooves, a brighter dorsal band, and the upper surface of the basal joints of the legs mottled with tan or yellowish-green like the dorsal stripe. In *P. elongatus*, the upper surface of the legs is dark like the upper sides.

Bishop, 1934, p. 169 (*Plethodon dunni*); Fitch, 1936, p. 637; Jewett, 1936, p. 71; Slater, 1939, p. 154.

DEL NORTE SALAMANDER. *Plethodon elongatus* Van Denburgh. Fig. 66. Map 32.

TYPE LOCALITY. Requa, Del Norte County, California.

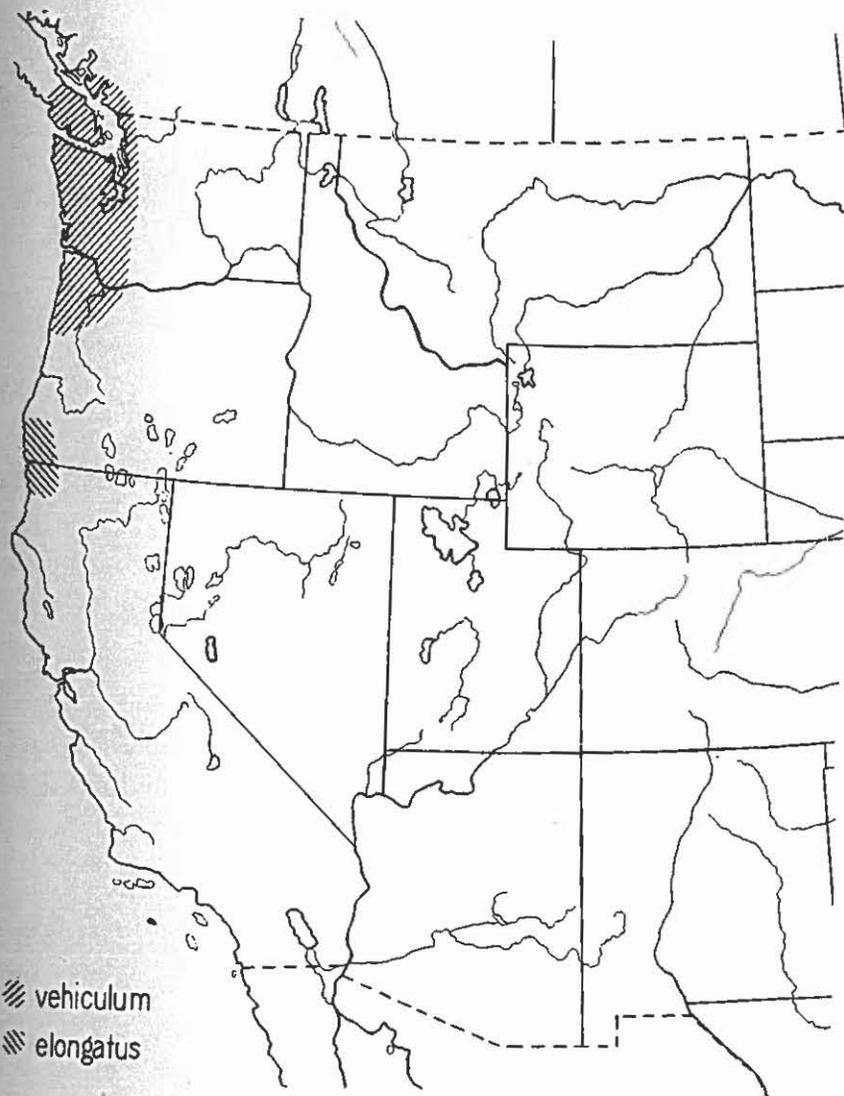
RANGE. Known from Del Norte County, extreme northwestern California, and from Curry County, southwestern Oregon.

HABITAT. Wood (1934, p. 191) records specimens from a south-facing slope well covered by redwood, Sitka spruce, and madroño (*Arbutus*). Here the salamanders were found beneath rotting logs and slabs of bark. Slevin (1928, p. 57) reports this species from beneath decaying logs in damp woods. Fitch (1936, p. 638) found 2 specimens in a rock slide in company with *Plethodon dunni*. On June 6, 1936, Margaret Wright and I, collecting at Carpentersville, Oregon, found specimens beneath stones and heat-splintered rocks on a fairly dry, wooded hillside that had been burned over.

SIZE. Two large females are 115 and 113 mm. long respectively and in each the tail measures 54 mm. Nine of the 11 specimens captured had lost the tips of the tails and had partially regenerated them. The proportions of the largest female are as follows: total length 115 mm., tail 54 mm.; head length 14 mm., width 8 mm.; 8 intercostal folds between the appressed limbs.

DESCRIPTION. This is a slender species with a general resemblance to the eastern, *Plethodon cinereus*. The head is long, relatively narrow, and with the sides nearly parallel to the eyes. In front of the eyes the sides converge abruptly to the blunt snout. The eyes are of moderate size but prominent, with the iris above and below the pupil brassy to dark brown. The trunk is nearly cylindrical, the tail broadly oval in section on the basal half but becoming somewhat compressed distally. The costal grooves number 17 in the majority of specimens I have examined, with some individuals having 18, counting 1 each in the axilla and groin, and 6-7 intercostal folds between toes of appressed limbs. In speci-

mens having 17 grooves, usually 2 run together in the groin. The legs are well developed but appear shorter than in most species of *Plethodon* because of the lengthening of the trunk. Toes 5-4, those of the hind feet with the innermost very short, others in order of length 5-2-3-4



MAP 32.—Distribution of *Plethodon vehiculum* and *P. elongatus*.

or 2-5-(3-4); toes of the fore feet 1-4-2-3, the 2nd and 4th about equal. The tongue is oval in outline, fleshy, and fills the floor of the mouth. The vomerine teeth are in 2 short series of 4-6 teeth, widely diverging anteriorly, the outermost behind the inner nares, the innermost of each row separated by about half the distance between the inner nares. The

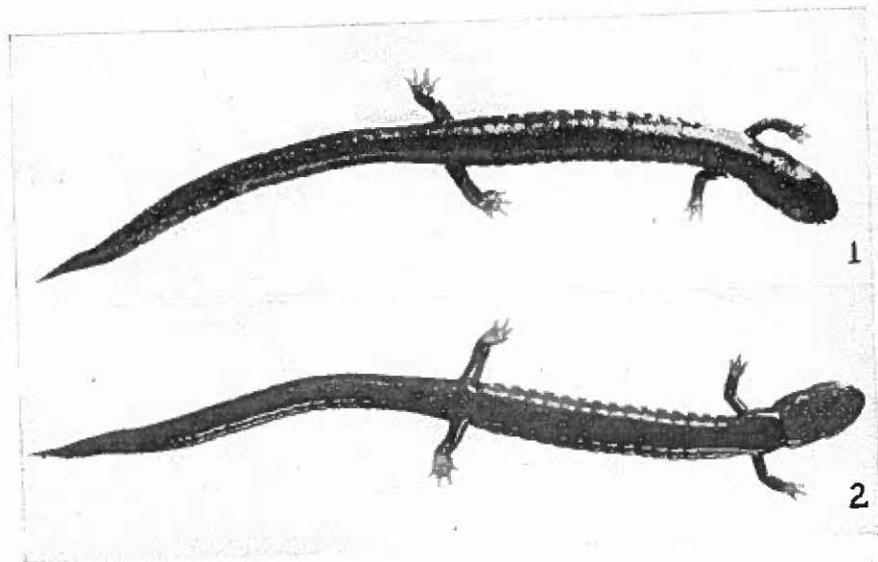


FIG. 66. *Plethodon elongatus* Van Denburgh. (1) Adult female, actual length $4\frac{1}{2}$ " (115 mm.). (2) Same, ventral view. Carpentersville, Oregon.

parasphenoid teeth form a large wedge-shaped patch, widest behind, where a deep notch separates the right and left sides, confluent in front, separated from the vomerine by a distance nearly equal to that between the inner nares.

COLOR. The general color above is deep brown, almost black—black to casual inspection. There is a broad dorsal band which originates on the snout, passes between the eyes, broadens behind the eyes to the full width of the head, narrows to the neck, then continues the entire length of the trunk, gradually darkening toward the tip of the tail. In some individuals the dorsal band is scarcely evident, in others it may appear

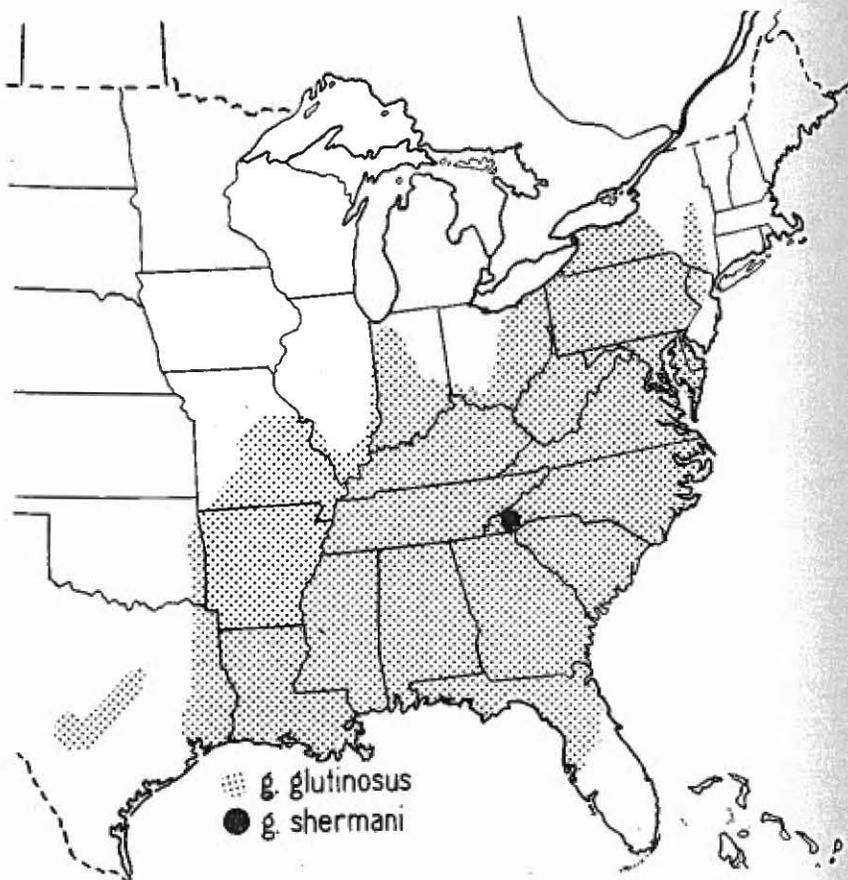
as a broad brown band strongly suffused with dusky, or a deep chestnut-brown. A half-grown individual has the lateral margins of the band tinged with orange, the center suffused with dusky. A small specimen 49 mm. long (tip of tail lost) has the margins of the band a bright reddish-orange, the center dusky. Storer (1926, p. 104), commenting on one of the original specimens described by Van Denburgh, remarks that the color of the dorsal band (in alcohol) is bright pink, clouded on the head and middorsal line with dark brown. The ground color on the lower sides fades to a dark slate. Venter slate. In some specimens the color on the sides and venter is quite uniform, but in others the sides of the trunk and head and the ventral surfaces of the trunk, throat, and legs are marked with many small, irregular, whitish flecks. The throat in front of the gular fold is dirty light brown. This species resembles *Plethodon vehiculum* in some of its color phases, but differs in eye color, in having the dorsal band more strongly diffused with dusky, and in its different costal-groove count. Furthermore, the upper surface of the basal joints of the legs in *P. vehiculum* are the same color as the dorsal band, while in *P. elongatus* the basal joints above are dark, like the upper sides.

BREEDING. Wood (1934, p. 191) collected in the region about Requa, Del Norte County, California, and on November 4, 1933, he took an adult *P. elongatus* from beneath a piece of redwood bark, together with two small clusters of eggs. The eggs were aggregated by a small amount of viscous jelly-like material. The individual eggs were about 3 mm. in diameter, nearly spherical, but drawn out on one side to form a point. Some of the eggs contained embryos approximately 15 mm. long. The ovarian eggs in some of the females we collected June 6, 1936, had attained a diameter of 1.5 mm. and presumably would have been deposited sometime later in the fall or early winter.

Fitch, 1936, p. 638 (*Plethodon elongatus*); Grinnell and Camp, 1917, p. 134; Slevin, 1928, p. 55; 1934, pp. 46, 53; Storer, 1925, pp. 21, 104; Van Denburgh, 1916, p. 216; Wood, 1934, p. 191.

SLIMY SALAMANDER. *Plethodon glutinosus glutinosus* (Green). Fig. 67.
Map 33.

TYPE LOCALITY. Probably in the vicinity of Princeton, New Jersey.
RANGE. New York south to northern half of Florida, the Gulf States



MAP 33.—Distribution of the subspecies of *Plethodon glutinosus*.

to Texas, northward through eastern Oklahoma, Missouri, southern Illinois to northern Indiana. This is a composite of several forms.

HABITAT. Usually found beneath logs and stones in woods, in crevices of shale banks, and along the sides of wooded gullies and ravines.

Frequently occurs under moist humus and is much more sensitive to dry air than the Red-backed salamander, burrowing deeply in dry seasons.

SIZE. This is one of the larger species of *Plethodon*, the males attaining a greater size than the females. Mature males vary from $4\frac{3}{4}$ " to $7\frac{7}{16}$ " (121–188 mm.) and average about $5\frac{7}{8}$ " (148 mm.). Adult females range in size from $4\frac{1}{4}$ " to $6\frac{1}{16}$ " (105–168 mm.) and average $5\frac{1}{16}$ " (143.6 mm.).

DESCRIPTION. The Slimy salamander has the head only moderately broad, widest just behind the eyes, the sides nearly parallel or tapering slightly to the lateral extensions of the gular fold and more abruptly to the blunt snout. The trunk is rounded on the sides and slightly depressed above, the tail nearly circular in cross section and tapering to a slender tip. There are 16 costal grooves and the gular fold is developed as a transverse crease. The legs are strong, the toes 5–4, those of the fore feet 3–2–4–1 in order of length, rather short and slightly webbed at base; toes of the hind feet, 3–4 about equal, others 2–5–1. The vomerine teeth, 10–13 in each series, form somewhat irregular, backward-curving lines that are separated from each other and the parasphenoids, the latter usually in 2 patches. The tongue is broad and flat, nearly fills the floor of the mouth, and has the side margins free. The general ground color above is black or blue-black, with the belly light slate color and the throat and gular region very slightly paler and sometimes mottled. The distal third of the tail is dull brown in many adult specimens. Scattered over the sides of the body, and sometimes over the dorsal surface, except the tip of snout and tail, are many silvery-white flecks, variable in size and shape. In some individuals from the South, the light spots of the sides tend to run together and form incomplete bands; in others the spots may be nearly lacking. In the sexually mature males there is a well developed mental gland that appears as a rounded, slightly raised, light spot on the tip of the lower jaw, and the vent is lined with papillae.

BREEDING. Little is known of the breeding habits of this species. The

eggs, accompanied in one instance by a female, were reported from Arkansas caves (Noble and Marshall, 1929). One lot containing 18, found August 17, was suspended from the vertical wall of a little pocket

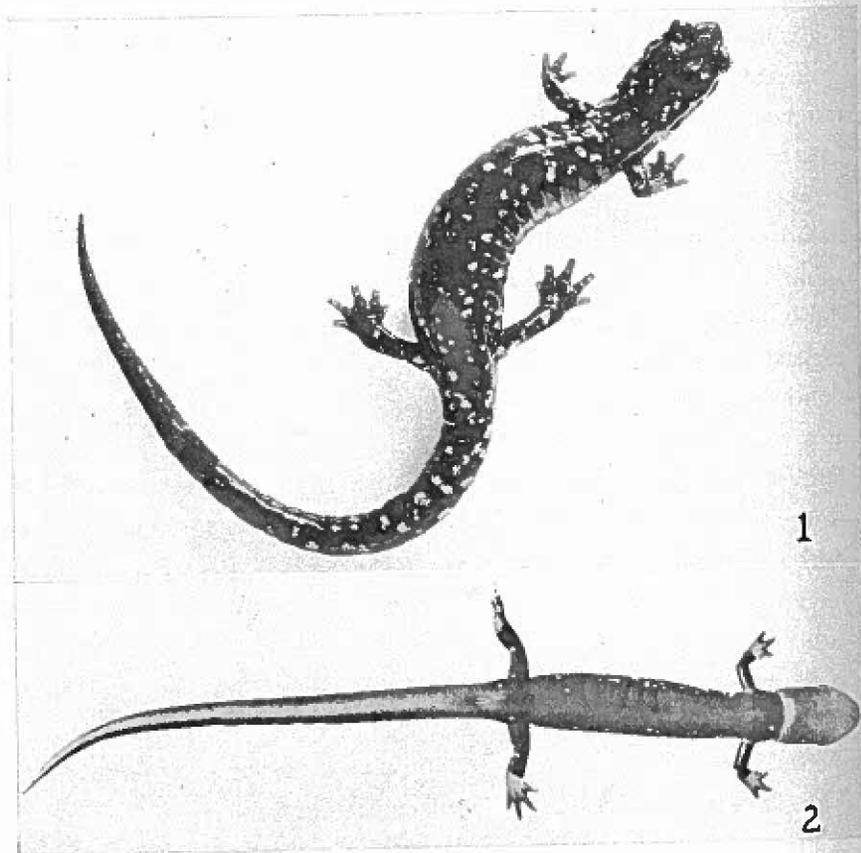


FIG. 67. *Plethodon glutinosus glutinosus* (Green). (1) Adult female, actual length about $6\frac{1}{16}$ " (160 mm.). Woodville, Canandaigua Lake, New York. (2) Adult female, ventral view; actual length $5\frac{1}{8}$ " (149 mm.). Allegany State Park, New York.

near the entrance, and the second, containing 10 well developed embryos, found Sept. 3, lay at the bottom of a little crevice about 200 feet from the entrance. The eggs were aggregated by a relatively thin, common envelope and were not stalked. The average egg has a diameter of 5.5 mm. and is creamy-white in color. In addition to the vitelline membrane

there are 2 distinct envelopes which give a total diameter of 7.5 mm. An account of the discovery of a female with her eggs on Ice Mountain, Hampshire County, West Virginia, has recently been given by Fowler (1940, p. 133). On June 3, 1938, the female was discovered coiled about a group of about 15 eggs under a rotting stump on a wooded hillside. Nothing is known of the length of the period of incubation, the size at hatching, or the extent of the period the gills are retained. The well developed embryos resemble those of *Plethodon cinereus* in their possession of a dorsal stripe and broad, leaf-like gills arising from a common base. The dissection of females indicates that, farther north, the egg-laying season may be in the early spring months. Large ovarian eggs are found from October to December, and again, in some individuals, in May and June. Other females, taken as early as May and through the summer months, generally have very small eggs, indicating that the season's complement had been laid. Males taken in October have the vas deferens packed with sperm, suggesting an autumnal mating season, at least in the North. The Slimy salamander buries itself deeply at the approach of winter, and it is likely that the eggs will be found in the crevices of shale banks, or well below the surface of the ground, in situations which serve as hibernating retreats.

RED-LEGGED SALAMANDER. *Plethodon glutinosus shermani* Stejneger.
Fig. 68. Map 33.

TYPE LOCALITY. Wayah Bald Mountain, North Carolina.

RANGE. Nantahala Mountains in southwestern North Carolina.

HABITAT. Wooded slopes and thickets of Rhododendron, hiding by day beneath old logs, planks, and bark, more rarely beneath stones and rocks, especially where moss-covered and somewhat imbedded. Sometimes associated with *Plethodon g. glutinosus*.

SIZE. My largest specimen, a female, has a total length of $6\frac{1}{16}$ " (153 mm.) and a tail length of $3\frac{5}{8}$ " (80 mm.). Five females average $5\frac{1}{8}$ " (130.2 mm.) and vary from $4\frac{9}{16}$ " to $5\frac{15}{16}$ " (115 to 147 mm.). The males I have measured average considerably smaller. The proportions

of a typical female are as follows: total length $5\frac{1}{16}$ " (128 mm.), tail $2\frac{1}{16}$ " (68 mm.); head length $\frac{5}{8}$ " (15 mm.), width $1\frac{3}{32}$ " (9.5 mm.). Male, total length $4\frac{1}{8}$ " (115 mm.), tail $2\frac{1}{4}$ " (57 mm.); head length $\frac{5}{8}$ " (15 mm.), width $\frac{3}{8}$ " (9 mm.).

DESCRIPTION. This is a slender, black salamander with red in irregular blotches on the legs. Viewed from above, the head is broadly oval in outline, widest immediately back of the eyes, tapering quite abruptly to the short snout and more gently to the lateral extensions of the gular fold. The eyes moderate but strongly protuberant, the posterior angle with a short vertical groove. Gular fold well developed and extending on the side of the neck, where it is met by a sinuous line from the posterior angle of the eye; a short vertical groove from this to the angle of the jaw. The trunk is rounded on the sides and above, slightly flattened ventrally. A median dorsal groove extends from the back of the head to the base of the tail. The tail is long, in some individuals comprising 56 per cent of the total length, nearly circular in section and gently tapering from base to tip. Costal grooves 15 or 16, counting 1 each in axilla and groin, where there is always space for one whether or not it is developed; 1-2 intercostal spaces between toes of appressed limbs. Legs moderately stout, toes 5-4, those of the hind feet 1-5-2-3-4 or 4-3, the innermost very short, all very slightly webbed at base; toes of the fore feet, 1-4-2-3. Tongue fairly large, nearly filling the floor of the mouth, the margins free, thin, and smooth. Vomerine teeth somewhat variable, in the females 9-9 to 9-11 or 11-12; in the males usually fewer, 7-8 to 8-9. The series begin outside the outer edge of the inner nares, curve gently inward and backward, and are separated at the mid-line by a distance about equal to the width of a naris. Parasphenoid teeth in 2 narrowly separated club-shaped patches and distant from the vomerine by about twice the diameter of an inner naris.

COLOR. In the living, typically colored individual the ground color above is a lustrous blue-black, with the tail a little lighter, tending toward slate. Lower sides light gray. In some individuals the ground color may be bluish-brown. The legs above are mottled with bright

red in irregular blotches and varying much in extent; in some individuals reduced to a few scattered flecks. Feet generally lighter, brownish or tan. The throat is light, but very finely speckled with small black chromatophores, slightly darker on the sides. The belly and ventral

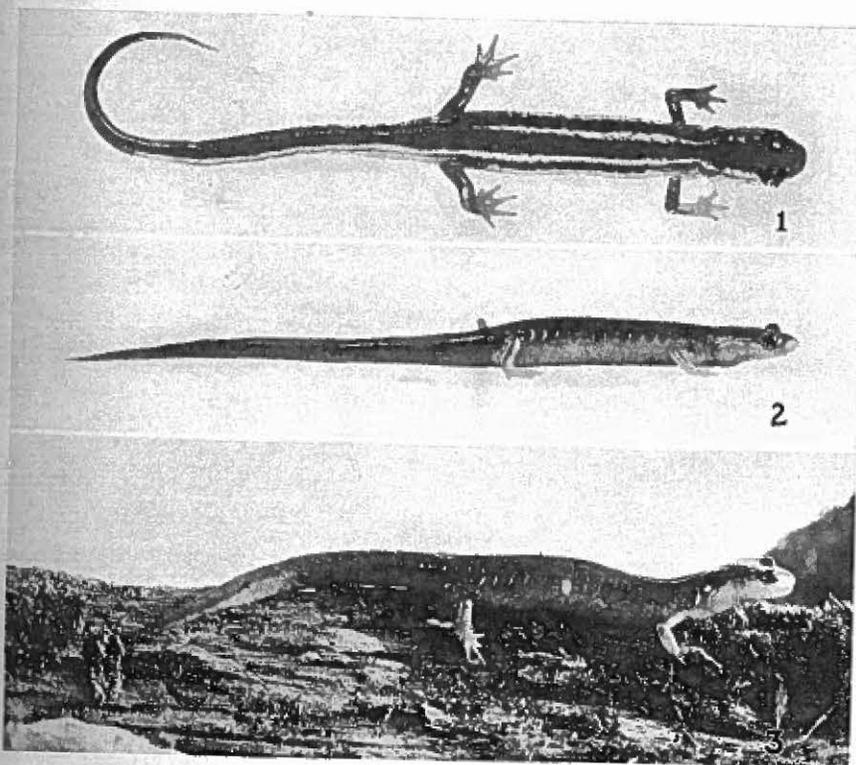


FIG. 68. *Plethodon glutinosus shermani* Stejneger. (1) Adult, actual length about $5\frac{1}{8}$ " (131 mm.). (2) Same, lateral view. (3) Same, dorsolateral view. Nantahala Gap, North Carolina.

surface of the tail may be pale bluish-white or pale gray, sometimes blotched irregularly on the sides between the fore and hind legs. Some individuals may have the throat and feet flesh color, or the feet may be yellowish-gray.

SEXUAL DIFFERENCES. Sexual differences are not well marked. The sexually mature male has the tip of the lower jaw slightly pointed, and

there is a well developed mental gland; the sides of the vent are raised, thickened, and crossed anteriorly by a number of narrow grooves. Posteriorly the sides of the vent are developed into a pair of flat, fleshy lobes which may have the hind margins free. The tip of the lower jaw in the female is evenly rounded and the sides of vent are not produced behind into fleshy lobes.

BREEDING. Nothing is known of the breeding habits. A large female, taken in October 1926, has ovarian eggs 2 mm. in diameter, while those collected in April 1938 have a considerable number of very small eggs.

SACRAMENTO MOUNTAINS SALAMANDER. *Plethodon hardii* Taylor. Fig. 69. Map 31.

TYPE LOCALITY. Sacramento Mountains, Cloudcroft, New Mexico.

RANGE. Known only from the vicinity of the type locality, altitude about 9000', and from Aqua Chiquite, Otero County, New Mexico.

HABITAT. The type was found under the bark of a rotten pine log in heavy pine forest. On July 17, 1942, Dr. and Mrs. A. H. Wright collected, near Cloudcroft, a fine series of juveniles and adults in and beneath old logs and bark and under the bark at the base of stumps. At this locality the specimens were mostly in shady, moist situations beneath pines and spruces.

SIZE. The average length of 10 adults of both sexes from Aqua Chiquite, New Mexico, is $3\frac{3}{32}$ " (77 mm.), the extremes $2\frac{5}{8}$ " (67 mm.) and $3\frac{11}{16}$ " (94 mm.). The proportions of an adult male are as follows: total length $3\frac{11}{16}$ " (94 mm.), tail $1\frac{3}{4}$ " (45 mm.); head length $1\frac{5}{32}$ " (12 mm.), width $\frac{5}{16}$ " (8 mm.). The measurements of a female are: total length $3\frac{3}{8}$ " (80 mm.), tail $1\frac{7}{16}$ " (37 mm.); head length $1\frac{3}{32}$ " (11 mm.), width $\frac{9}{32}$ " (7 mm.).

DESCRIPTION. This is a fairly slender species of moderate size. The head is large and strongly depressed. Back of the eyes the sides are nearly parallel or slightly converging to the lateral extensions of the prominent gular fold, in front tapering rather abruptly to the truncated snout. The eye is large and strongly protuberant, the horizontal diameter

about equal the snout, the iris with bright coppery tinges. A sinuous impressed line from the posterior angle of the eye to the lateral extension of the gular fold; a short vertical groove from this line to the

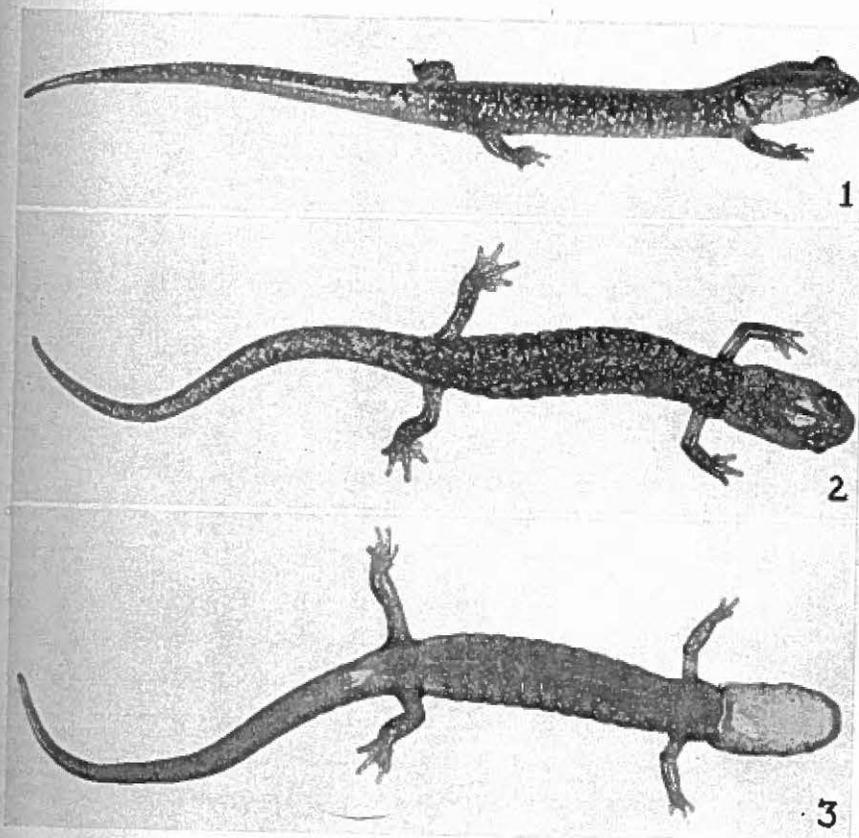


FIG. 69. *Plethodon hardii* Taylor. (1) Adult female, actual length $3\frac{3}{16}$ " (91 mm.). (2) Same, dorsal view. (3) Same, ventral view. Cloudcroft, New Mexico (type locality). [Anna A. and A. H. Wright, collectors, July 17, 1942.]

angle of the jaw. Trunk slender, with 14-15 costal grooves and $3\frac{1}{2}$ or more costal grooves between the toes of the appressed limbs. Tail slender, and comprising 42-53 per cent of the total length. Legs well developed. Toes 5-4, those of the hind feet 1-5-2-4-3 in order of length from the shortest, webbed at base, flattened and square-tipped; toes of

the fore feet 1-4-2-3, webbed at base, first rudimentary. Tongue elongate oval, free at the sides and behind. Vomerine teeth in transverse series of 6-10 (the average about 8) which arise behind the middle of the inner nares and slant inward toward the mid-line, where they are separated by less than the width of a naris. Parasphenoid teeth in elongate patches, usually narrowly separated but occasionally contiguous anteriorly, and separated from the vomerine by about twice the diameter of a naris. The sexes may be distinguished by the form of the vent, that of the male having the margins crossed by transverse grooves and provided internally with many slender papillae; the vent of the female is a simple slit. An adult male has a circular mental gland.

COLOR. The ground color above is nearly black, mostly obscured by overlying pigment which varies in color from dull clay to grayish-tan and bronze. The head is usually more uniformly bronze, suffused with dusky, and the tail brighter than the trunk. The overlying pigment may be disposed in large blotches with irregular edges or form a nearly uniform, broad, dorsal stripe. The tail may be uniformly colored above or irregularly invaded by the dark gray of the sides. On some young individuals, the dorsal color is disposed in a fairly regular band, limited either side by a darker line. The upper sides are irregularly blotched and mottled between the conspicuous black costal grooves, the lower sides more sparsely spotted over a bluish-black background. The belly is slate, the throat very light but lightly mottled, the lower surface of the tail flesh to light brown. The legs are colored above like the back, below like the lower surface of the tail. The costal grooves are very conspicuous in life, with extensions dorsally and ventrally nearly or quite to the mid-line. The sides of the tail, on the basal part, are marked with impressed vertical grooves.

BREEDING. Nothing is known of the breeding habits, eggs, or recently hatched young.

COEUR D'ALENE SALAMANDER. *Plethodon idahoensis* Slater and Slipp. Fig. 70. Map 31.

TYPE LOCALITY. Coeur d'Alene Lake, Kootenai County, Idaho.

RANGE. Known only from the type locality.

HABITAT. "All five of the specimens were taken at the foot of a high cut bank above the road which follows the edge of Coeur d'Alene

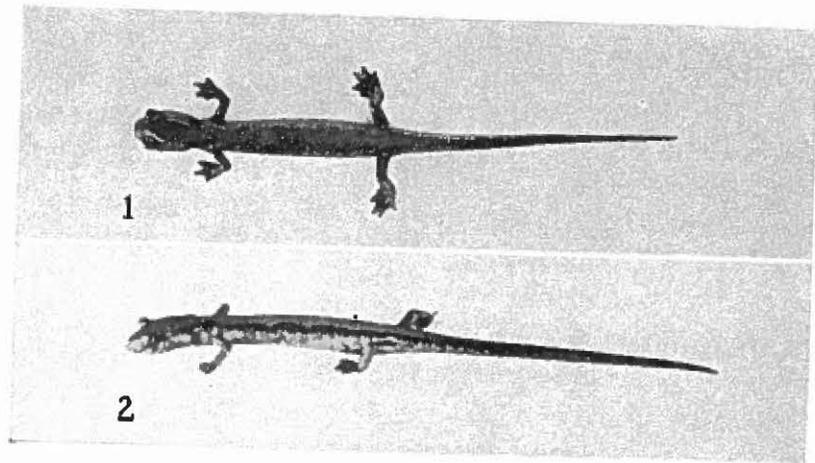


FIG. 70. *Plethodon idahoensis* Slater and Slipp. (1) Adult, dorsal view; about natural size. (2) Same, lateral view. Coeur d'Alene Lake, Idaho. [Photographs by courtesy of J. R. Slater.]

Lake, the two adults from a rock and dirt talus and the three juveniles from the gravel floor at the entrance of a very wet mine .6 of a mile distant. . . . The forest in this vicinity has a humid aspect, containing much douglas fir and dwarf maple, while a few miles westward the yellow pine and open plains of the arid transition predominate" (Slater and Slipp, 1940, p. 43).

SIZE. This is a species of moderate size, the 2 adults having measurements as follows: Type, male (U.S.N.Mus. No. 110504), total length 4" (101.5 mm.), tail $1\frac{25}{32}$ " (46 mm.); head length $1\frac{15}{32}$ " (12 mm.), width $\frac{5}{16}$ " (8 mm.). Adult female, No. 2711 in the collection of the College of

Puget Sound, total length $3\frac{1}{16}$ " (78 mm.), tail $1\frac{1}{32}$ " (34 mm.); head length $\frac{3}{8}$ " (10 mm.), width $\frac{9}{32}$ " (6.4 mm.). The smallest specimen secured had a total length of $1\frac{1}{32}$ " (34 mm.).

DESCRIPTION. The head is broad and depressed, the sides back of the eyes slightly converging to the lateral extensions of the gular fold, in front more abruptly to the squarely truncated snout, which is slightly swollen in the region of the nasolabial grooves. Eyes large and very strongly protuberant, the horizontal diameter once in the snout; iris brown, tinged with gold or brassy. Eye limited behind by a vertical fold; an impressed line from the posterior angle of the eye to the lateral extension of the gular fold, and a vertical groove from this line to the angle of the jaw. Trunk moderately stout, rounded on the sides and above, with an impressed median line. Costal grooves 13, or 14 counting 2 that run together in the groin, and about 3 intercostal folds between the toes of the appressed limbs. Tail subquadrate in section at base, long, slender, tapering, and slightly compressed distally. Legs stout. Toes 5-4, those of the hind feet 1-5-2-(4-3) in order of length from the shortest, first rudimentary, all slightly webbed at base. Toes of the fore feet 1-4-2-3, the 1st short, others slightly webbed at base. Tongue elongate oval, free at the sides and behind, thin at margins. Vomerine teeth in short series of 9-10 that arise behind the inner margin of the inner naris and slant obliquely backward and inward toward the midline, where they are separated by about the diameter of a naris. Parasphenoid teeth in 2 long slender patches, narrowly separated from one another and from the vomerine by about three times the diameter of a naris.

COLOR. The ground color above is black. There is a broad, middorsal, yellow band that arises on the snout and continues to the tip of the tail. The yellow band narrows to a blunt point on the snout, widens to include the upper eyelids, and narrows at the neck. It is strongly suffused with brownish on the head, becomes bright yellow on the tail base, and is again suffused with brownish toward the tip. The sides of the dorsal band are slightly irregular. The sides and venter are black,

with lighter areas on the throat, sides of the head, and tips of the toes, and a general scattering of small gray flecks.

BREEDING. Nothing is known of the breeding habits, and the eggs and recently hatched young are unknown.

RED-CHEEKED SALAMANDER. RED-NECKED SALAMANDER. *Plethodon jordani* Blatchley. Figs. 49e, 71. Map 30.

TYPE LOCALITY. Mt. Collins and Indian Pass, Sevier County, Tennessee.

RANGE. The Great Smoky Mountains in western North Carolina and eastern Tennessee.

HABITAT. This species is abundant in and beneath old rotten, moss-covered logs and bark and, more rarely, beneath stones and slabs of rock, on the heavily forested slopes of the Smoky Mountains. On April 18, 1938, we collected at the type locality, Indian Pass, Sevier County, Tennessee, with Mr. Willis King, and found this species to be extremely abundant. We have also taken this species in numbers along the heavily shaded banks of Mill Creek on the slopes of Mt. Le Conte between 2500-5500'.

SIZE. A series of 10 adults of both sexes from Indian Gap, Tennessee, average $4\frac{7}{16}$ " (112.5 mm.). The largest specimen taken, a female, has a total length of $5\frac{5}{16}$ " (135 mm.), tail $2\frac{1}{16}$ " (65 mm.); head length $2\frac{3}{32}$ " (18 mm.), width $\frac{3}{8}$ " (10 mm.). The proportions of a male are as follows: total length $4\frac{17}{16}$ " (119 mm.), tail $2\frac{3}{8}$ " (60.5 mm.); head length $\frac{9}{16}$ " (14 mm.), width $\frac{3}{8}$ " (9 mm.).

DESCRIPTION. A distinctively marked and easily recognized salamander, apparently limited to the Great Smoky Mountains. The head is widest immediately back of the eyes, where it appears slightly swollen. Behind this point the sides converge very slightly to the lateral extensions of the gular fold; in front of the eyes, the sides taper abruptly to the rather pointed snout. Eyes large and protuberant, posterior angle limited by a short vertical fold. Gular fold well developed; a deep sinuous groove from the posterior angle of the eye to the lateral extension of the gular fold; a short vertical groove from this to the angle of the jaw.

Trunk moderately stout, well rounded on the sides and above, slightly flattened beneath. Tail long, averaging about 50 per cent of the total length, nearly circular in cross section at base, evenly tapering to the slender tip. Costal grooves 15-16, counting 1 in the axilla, which is usually poorly developed, and 1 in the groin, where frequently 2 run together; 2-3 intercostal spaces between toes of appressed limbs. Limbs stout, larger than in most species of *Plethodon*. Toes 5-4, those of the hind feet 1-5-2-4-3 in order of length from the shortest, the innermost rudimentary; toes of fore feet 1-2-4-3 or 1-4-2-3, not webbed at base. Tongue fairly large, the margins thin and smooth. Vomerine teeth 7-10, the series arising behind or just outside the outer edge of the nares, curving gently inward and backward toward the mid-line, where they are separated by about twice the diameter of an inner naris. Parasphenoid teeth in a large patch narrower in front than behind, where it is broadly rounded, and with a narrow, elongate area free from teeth through the center.

COLOR. The general color above in life is a deep blue-black, with the legs and feet a little lighter, grayish-brown. The head in some individuals is a deep brown. Cheeks dull pink to bright red, the area limited behind by the lateral extensions of the gular fold, above by the impressed line running from the eye to the gular fold, in front by the eye, and below, anteriorly, by the lower margin of the upper jaw; posteriorly extending varying distances on the throat. The extreme lower sides and belly are dull bluish-gray; the throat, fading anteriorly to dull flesh color. Rarely the red may be lacking on the cheeks or greatly decreased in extent. In a few individuals, of the several hundred I have collected, the red completely encircled the throat behind the angle of the jaw. Other individuals have the red areas invaded by varying amounts of black pigment. The lower surfaces of the feet and legs are colored generally like the belly. Tail beneath, usually darker than belly, but lighter than dorsal surface. A single adult animal from Indian Gap, Tennessee, taken April 18, 1938, has the red encroaching broadly on each side of the throat, a few spots on the fore legs, and a series of dull red, paired

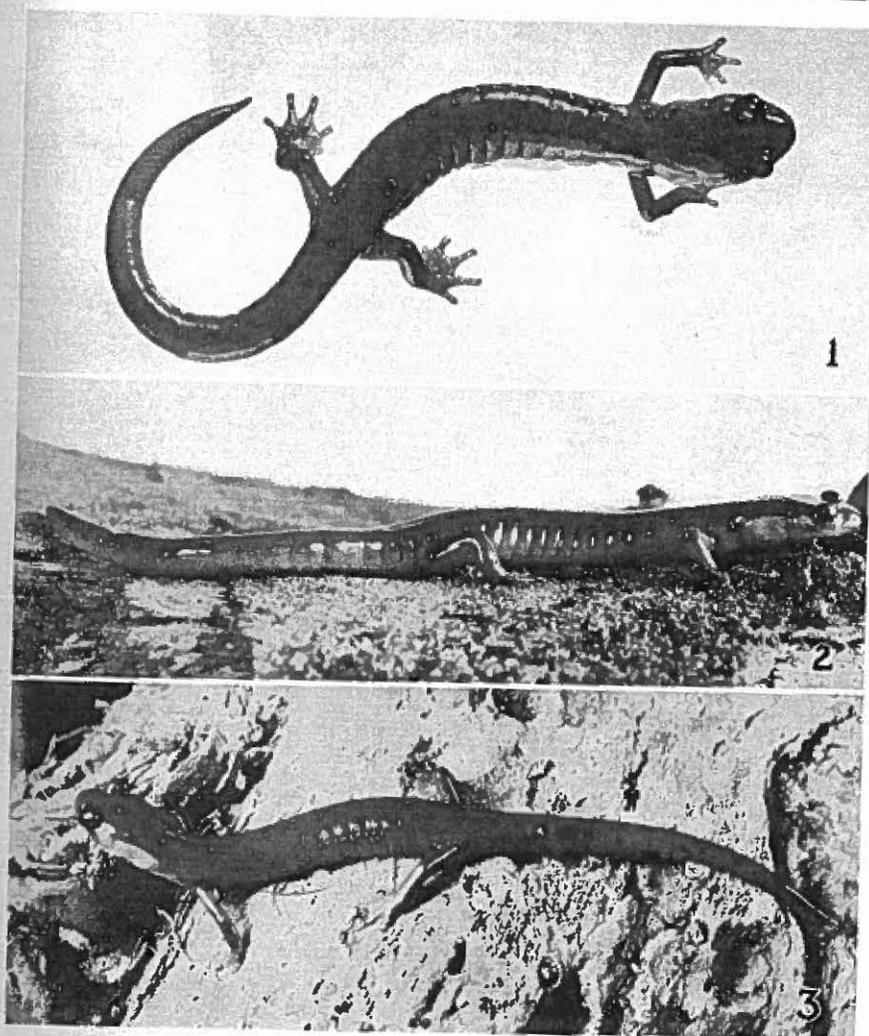


FIG. 71. *Plethodon jordani* Blatchley. (1) Adult, actual length about $4\frac{5}{16}$ " (110 mm.). (2) Same, lateral view. (3) Same, dorsolateral view. Mount Le Conte, Tennessee.

spots on the dorsum of the trunk. My smallest specimen, 29 mm. long (tip of tail lost), is colored like the adults. Bailey (1937, p. 6) mentions two small specimens ("snout to vent, 22.3 and 24.0 mm.") having faint dorsal areas suggestive of juvenile dorsal spots. The sexes may be distinguished in adults by the presence, in the males, of a well developed

mental gland, circular in outline, and by the slightly more pointed lower jaw.

BREEDING. Nothing has been published on the breeding habits of this species. Female taken at Indian Pass, Tennessee, in April 1938, had ovarian eggs about 1 mm. in diameter, and the males had large testes. The eggs and early stages have not been described.

METCALF'S SALAMANDER. *Plethodon metcalfi* Brimley. Fig. 72. Map 35.

TYPE LOCALITY. Sunburst, Haywood County, and Grandfather Mountain, North Carolina.

RANGE. Ranges of the southern Blue Ridge Mountains (except the Great Smokies and Nantahalas) from southwestern Virginia through western North Carolina, northern South Carolina, to northern Georgia; Roan Mountain, Tennessee, and possibly northeastern Alabama.

HABITAT. Common on wooded slopes, where they hide by day beneath old logs, bark, stones, and slabs of rock. On Big Pisgah, Big Bald, and Frying Pan Mountains, in western North Carolina, at localities where they were most abundant, the forests were mainly of oak and chestnut, with an undergrowth of *Cornus* and *Rhododendron*. Few specimens from above limits of large tree growth.

SIZE. Measurements given by Bailey (1937, p. 6) indicate that populations from high elevations, 4000–5800', average considerably smaller than those from elevations of 2300–3600'. Fifteen males from Blackrock, North Carolina, averaged in total length $3\frac{7}{8}$ " (98.7 mm.); 16 females, $4\frac{3}{16}$ " (106.4 mm.). Eleven males from Swannanoa, North Carolina, averaged $5\frac{3}{4}$ " (146.7 mm.); 12 females, $5\frac{5}{8}$ " (142.8 mm.). The proportions of a male from the east side of Grandfather Mountain, North Carolina, are as follows: total length $5\frac{3}{16}$ " (132 mm.), tail $2\frac{7}{8}$ " (73 mm.); head length $1\frac{1}{2}$ " (15 mm.), width $\frac{3}{8}$ " (9 mm.). A female of the same total length from Mt. Pisgah, North Carolina, has a tail length of $2\frac{5}{8}$ " (67 mm.); head length $\frac{5}{8}$ " (16 mm.), width $\frac{3}{8}$ " (9 mm.).

DESCRIPTION. This species is related to *P. jordani*, from which it differs in the absence of red cheek patches and in generally lighter color, to

P. shermani, from which it differs in the absence of red legs, and to *P. glutinosus*. The ground color is lighter than that of *P. glutinosus*, but occasionally specimens of *P. metcalfi* have scattered light spots quite suggestive of those so characteristic of the Slimy salamander. The head is rather broad and somewhat depressed, widest immediately back of the eyes, the sides gently converging behind; the snout short, bluntly

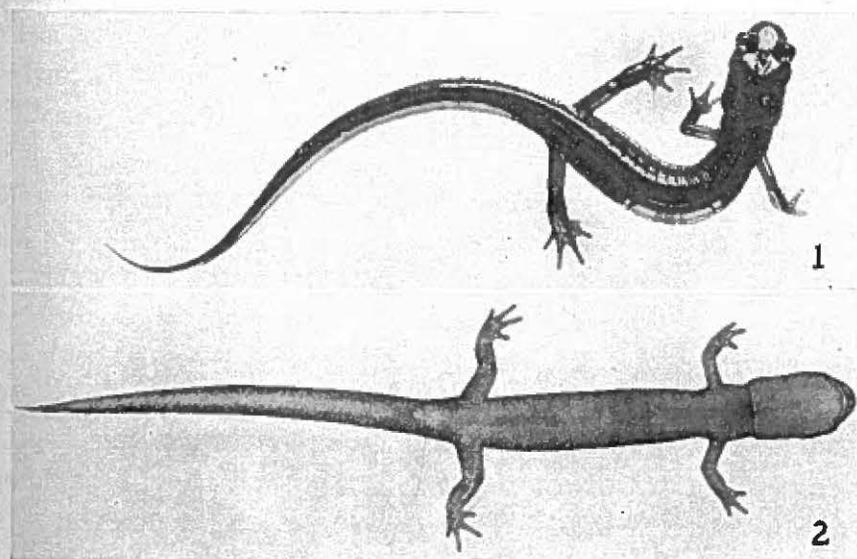


FIG. 72. *Plethodon metcalfi* Brimley. (1) Adult female, actual length $4\frac{13}{16}$ " (122 mm.). Frying Pan Gap near Mount Pisgah, North Carolina. (2) Adult male, actual length $4\frac{1}{16}$ " (103 mm.). Grandfather Mountain, North Carolina.

pointed, and somewhat swollen in the region of the nasolabial grooves. Eyes large and protuberant, posterior angle limited by a vertical flap under which both eyelids fit. Gular fold well developed, the neck noticeably smaller than the head. A deep, slightly sinuous groove from the posterior angle of the eye to lateral extensions of the gular fold; a short curved, vertical groove from this to the angle of the jaw. Trunk well rounded on the sides and above, with a slight median impressed line, below flattened. Tail long, normally in adults longer than head and trunk, nearly circular in cross section at base, evenly tapering to the

slender tip. Costal grooves 15-16, counting 1 each in axilla and groin, the usual number 16. About 2 intercostal spaces between the toes of appressed limbs in adults. Limbs stout; toes 5-4, slightly webbed at base, those of the hind feet 1-5-2-4-3 or 3-4 in order of length from the shortest; fore feet, 1-2-4-3. Tongue moderate, does not completely fill the floor of the mouth. Vomerine teeth 6-9, the series originating at the outer edge of the inner nares, curving inward and backward toward the mid-line, where they are separated by a little more than the diameter of a naris. Parasphenoid teeth in some forming 2 narrowly separated club-shaped patches; in other individuals the patches are united in front and narrowly separated behind.

COLOR. In life the general ground color varies from bluish-brown to purplish-gray above and is lighter than that of *P. jordani*, *P. g. shermani*, or *P. g. glutinosus*. The upper surface of the legs is lighter, dull grayish-white, and often there is a slightly lighter brownish area on the head between the eyes. The upper sides are colored like the back, the lower sides lighter, often bluish-white anteriorly and dull dirty white toward the hind legs. The belly is dull bluish or grayish. In some specimens there are tinges of lavender and flesh on the legs, the sides of the throat and just back of the gular fold. The throat is light, grayish-white with fleshy tinges around the margin of the lower jaw. The sexes may be distinguished by the presence, in the adult male, of a prominent mental gland and by the slightly more pointed lower jaw.

BREEDING. Nothing is known of the breeding habits of this species. The ovarian eggs are small in October and only slightly larger in April, so it is likely that egg-laying may take place in late summer.

CHEAT MOUNTAIN SALAMANDER. *Plethodon nettingi* Green. Fig. 73. Map 30.

TYPE LOCALITY. Barton Knob, Randolph County, West Virginia.

RANGE. KNOWN only from the vicinity of Cheat Bridge and Barton Knob, Randolph County, West Virginia.

HABITAT. Mainly confined to cool, shady ravines, where it is often to

be found hiding in moist, decaying logs and beneath rocks. In these situations it is often associated with *Plethodon cinereus*, *P. wehrlei* and *Desmognathus o. ochrophæus* (Green, 1938).

SIZE. This is one of the smaller species of *Plethodon*, the adults averag-

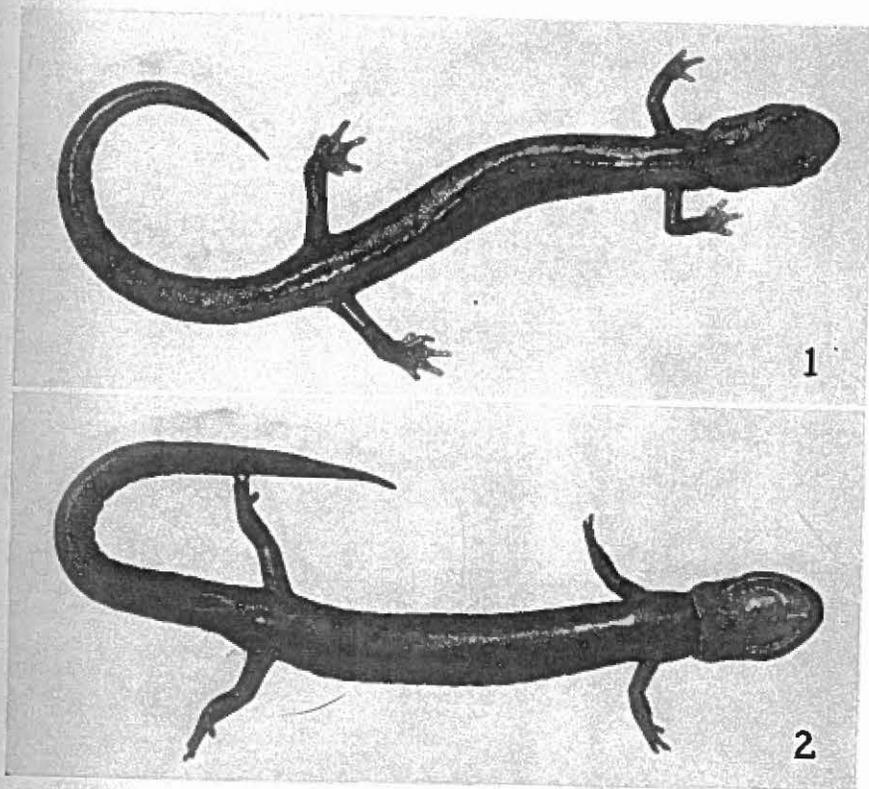


FIG. 73. *Plethodon nettingi* Green. (1) Adult female, actual length $3\frac{1}{8}$ " (79 mm.). (2) Same, ventral view. Upper Cheat Bridge, Randolph County, West Virginia.

ing about 3" (76 mm.) in total length. A mature female from Cheat Bridge, West Virginia, is proportioned as follows: total length $3\frac{1}{2}$ " (90 mm.), tail $1\frac{1}{16}$ " (43 mm.); head length $\frac{7}{16}$ " (10.5 mm.), width $\frac{1}{4}$ " (6 mm.).

DESCRIPTION. A small *Plethodon* with a very dark ground color and, in life, with many small brassy flecks scattered over the dorsal surfaces.

The head is somewhat depressed, widest immediately back of the eyes, tapering behind very slightly to the lateral extensions of the gular fold, and more abruptly to the bluntly pointed snout. The eyes are small but protuberant, the iris tinged with gold. Gular fold well developed and without pigment in the crease. A deep groove from the posterior angle of the eye to the lateral extension of the gular fold; a short vertical groove from this to the angle of the mouth. Trunk slender, rounded above and on the sides, and with a distinct median dorsal impressed line; costal grooves 17-19, counting 1 each in the axilla and groin, the usual number 18; $5\frac{1}{2}$ -6 intercostal spaces between the toes of the appressed limbs. Tail circular in cross section near base, evenly tapering to the slender and sometimes slightly compressed tip. Legs of moderate size, the hind a little larger in proportion to the fore than is usual in *Plethodon*; toes 5-4, those of the hind feet 1-5-2-4-3 in order of length from the shortest; fore feet 1-4-2-3, the 2nd and 4th about equal, all slightly webbed at base. The tongue fills the floor of the mouth, its margins thin and smooth. Vomerine teeth few and rather widely separated, usually 5-7 in each series, which arise behind the middle of the inner nares and extend inward and sharply backward, and are separated mesally by about the diameter of an inner naris. Parasphenoid teeth few and rather large, in 2 elongate club-shaped patches narrowly separated.

COLOR. The general ground color is deep brown, almost black, the head sometimes slightly lighter. Scattered over the dorsal surface of the head, trunk, and tail are many fine pale-brassy flecks which are more highly concentrated on the head and fade out on the distal third of the tail. The brassy flecks are continued sparsely on the sides of the head and on the upper sides of the trunk to the level of the upper surface of the legs, but are mainly limited to the dorsal surface of the tail. Legs and toes are a little lighter, with a few scattered flecks. The belly and the ventral surface of the tail, dark slate; the throat definitely lighter, grayish. Under low magnification the belly, and particularly the throat, are seen to have many small pigment-free spots.

BREEDING. A cluster of 8 eggs was collected with 2 adults in a decayed

hemlock log near Cheat Bridge on July 15, 1936, and reported by Green (1938, p. 297). Nine eggs with the attendant female were forwarded to me by Mr. M. Graham Netting from Upper Cheat Bridge, where they were found June 3, 1940. The eggs were held closely together by the adhesiveness of the outer envelopes and formed a compact mass. Individual eggs are about 4 mm. in diameter and are pale yellow, without pigment.

OUACHITA SALAMANDER. *Plethodon ouachitae* Dunn and Heinze. Fig. 74. Map 34.

TYPE LOCALITY. Rich Mountain, Ouachita National Forest, Polk County, Arkansas.

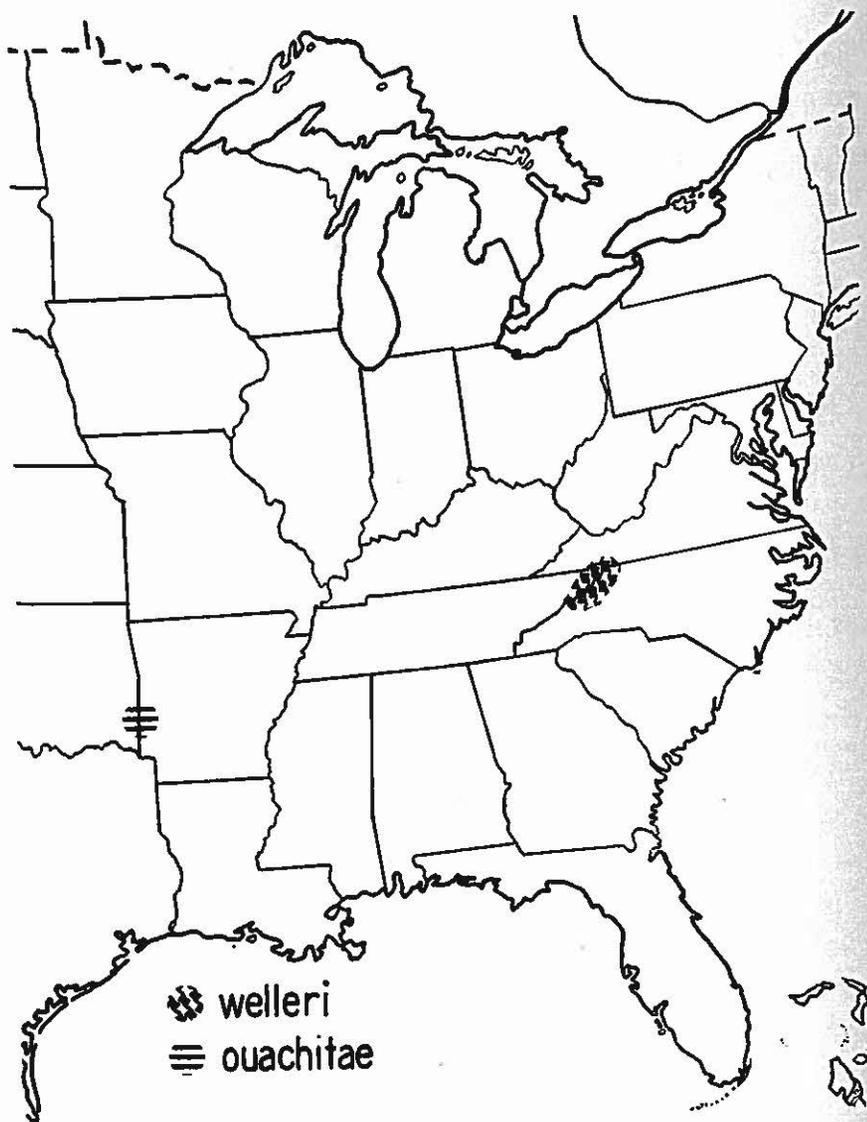
RANGE. Known from Rich Mountain, east of Page, Le Flore County, Oklahoma, and the Ouachita National Forest on Rich Mountain in Polk County, Arkansas. Doubtfully recorded by Burt (1935, p. 321) from 6 mi. northwest of the settlement of Rich Mountain.

HABITAT. The locality where most of the specimens have been secured is a moist, shaded ravine having a northern exposure. Rocks of boulder type are partially imbedded in the soil or piled one upon another, leaving deep crevices into which the salamanders may retreat.

SIZE. The series of specimens used by Dunn and Heinze (1933, p. 122) in their description of the species included males varying in length from $2\frac{15}{16}$ " (71 mm.) to $4\frac{3}{8}$ " (111 mm.) and females from $3\frac{9}{16}$ " (91 mm.) to $4\frac{1}{2}$ " (110 mm.). My largest specimen, a female, has the following proportions: total length $4\frac{3}{4}$ " (121 mm.), tail $2\frac{13}{32}$ " (61 mm.); head length $\frac{5}{8}$ " (15 mm.), width $\frac{3}{8}$ " (9 mm.).

DESCRIPTION. This species is closely allied to the group which includes *Plethodon glutinosus*, *P. yonahlossee*, and *P. wehrlei*. It is a slender species of moderate size. The somewhat depressed head has the sides back of the eyes nearly parallel or very slightly converging; in front the sides taper abruptly to the pointed snout. Eyes large and prominent, the lids limited behind by a short vertical fold of skin. From the posterior angle of the eye a sinuous line to the lateral extension of the gular fold;

a short vertical groove from this line to the angle of the jaw. The sides and dorsum of the trunk are rounded, but there is little evidence of a median dorsal impressed line; the belly is slightly flattened. The tail



MAP 34.—Distribution of *Plethodon welleri* and *P. ouachitae*.
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is nearly circular in cross section, slightly flattened, and strongly glandular at the base above. Costal grooves 15-17, the usual count being 16 when 1 each is counted in the axilla and groin. Usually 1-3 intercostal spaces between toes of appressed limbs. Legs moderate, toes short, thick, bluntly tipped, 5-4, those of the hind feet 1-2-5-3-4 in order of length

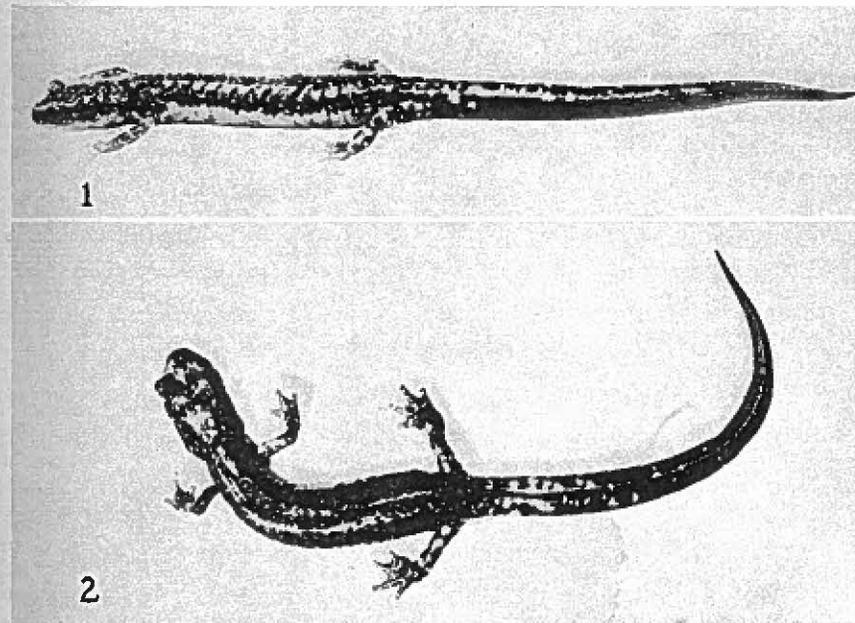


FIG. 74. *Plethodon ouachitae* Dunn and Heinze. (1) Adult female, actual length $4\frac{1}{16}$ " (120 mm.). (2) Same, dorsal view. Rich Mountain, Arkansas. Topotype.

from the shortest, the innermost rudimentary; toes of the fore feet 1-2-4-3. Tongue moderate, the sides thin, free, and smooth. Vomerine teeth 7-9 to 9-13 in each series, which arise just outside the outer margin of the inner naris and curve inward and backward and are separated at the mid-line by about the diameter of an inner naris and from the parasphenoid by a little more. Parasphenoid teeth usually in a broad patch only slightly notched anteriorly; in some the anterior halves separated by a narrow groove.

COLOR. The color, in life, of the head and trunk above is chestnut-

brown overlying a generally darker ground color. In this dorsal area the numerous small and crowded light spots are bright brassy or golden. On the dorsal surface of the tail, where the ground color is generally darker, the light spots are silvery-white and are fewer and larger, the distal third usually nearly free. The upper sides are chestnut varied with black, the sides of the tail dull brown and with few light markings. On the lower half of the sides, between the fore and hind legs, there is a broad white band with an irregular upper edge. This light band is continued on the sides of the head, where it is more or less broken. The throat is light pink, nearly white, but mottled to a greater or less extent by aggregations of small dark pigment flecks. The lower surface of the fore limbs is usually mottled, that of the hind legs and tail black. The legs are spotted above with white on a brown or black ground.

Preserved specimens lose this striking color pattern and the general impression is that of a blackish salamander having a light throat and a few light spots along the lower sides, quite resembling some preserved specimens of *Plethodon g. glutinosus*. Some preserved specimens have the distal half of the tail a dull brown.

BREEDING. Nothing has been published on the breeding habits of this species, but a female sent me by Mr. Albert A. Heinze, taken May 1, 1933, at Rich Mountain, Polk County, Arkansas, has the ovarian eggs averaging about 3 mm. in diameter and apparently ready to be deposited.

RAVINE SALAMANDER. *Plethodon richmondi* Netting and Mittleman.
Fig. 75. Map 30.

TYPE LOCALITY. Huntington, Cabell County, West Virginia.

RANGE. From Everett, Bedford, and Pittsburgh, Allegheny County, Pennsylvania, south to Wayne County, West Virginia. Also in Fayette Counties, Kentucky, and southeastern Ohio west to Canton.

HABITAT. "Exhibits a marked preference for the deep or narrow ravines, never occurring on hilltops, and only rarely on the upper slopes."
(Netting and Mittleman, 1938, p. 303.)

SIZE. Netting and Mittleman (*ibid.*) give the maximum length as 130 mm., with the average of a series, selected at random, as 105 mm. A female sent to me by Mr. Neil D. Richmond has body proportions as

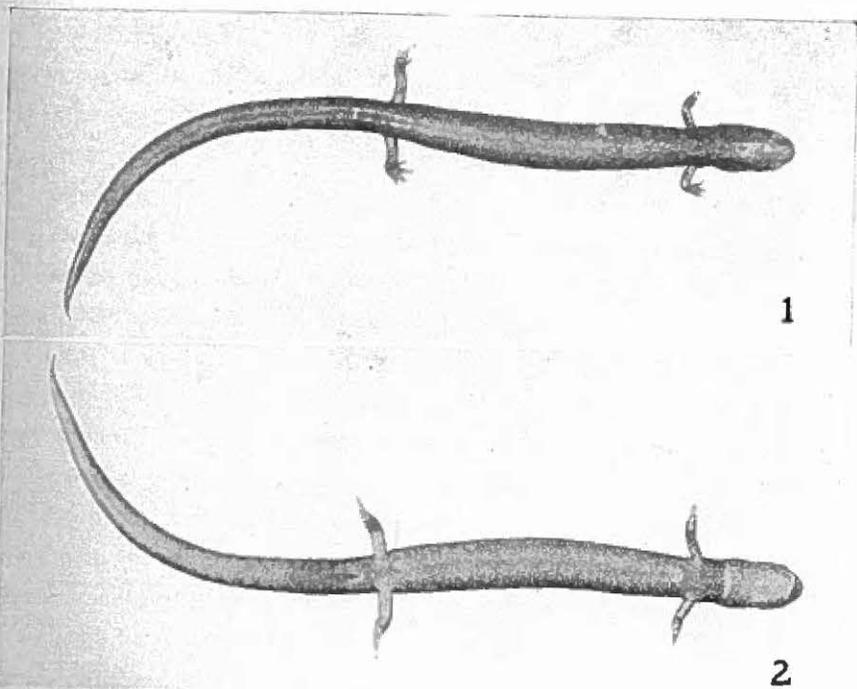


FIG. 75. *Plethodon richmondi* Netting and Mittleman. (1) Adult female, actual length $4\frac{7}{16}$ " (112 mm.). (2) Same, ventral view. Bristol, West Virginia. [Photographs from a preserved specimen.]

follows: total length $4\frac{3}{4}$ " (120 mm.), tail $2\frac{3}{8}$ " (60 mm.); head length $\frac{5}{16}$ " (12 mm.), width $\frac{1}{4}$ " (6 mm.).

DESCRIPTION. A slender *Plethodon* with the general appearance of a head-colored *P. cinereus*, but with a higher costal groove count and other anatomical differences. To me it seems closely related to *P. cinereus* in its general form and coloration. The head is long and slender, with a distinct depression behind the eyes, in front tapering to the bluntly pointed snout, behind with the sides slightly converging. Eyes with the iris a light brownish black. Gular fold well developed, light in color and with-

out pigment in the crease. A sinuous groove from the posterior angle of the eye to the lateral extensions of the gular fold, a short curved groove from this to the angle of the jaw. Trunk slender and rounded, costal grooves 20-21, rarely to 23, counting 1 each in axilla and groin; 9-10 costal folds between appressed limbs; tail circular in section, at base sometimes slightly flattened above, tip slender. Legs small, slender; toes 5-4, considerably webbed at base, those of the hind feet 1-5-2-4-3 in order of length from the shortest; fore feet 1-4-2-3, innermost rudimentary and entirely within the web. Tongue circular, moderate, the edges narrowly depressed. Vomerine teeth in 2 short series, 5-6 teeth in each, separated by about the width of an internal naris and extending at least to outer edge of naris; parasphenoid teeth in 2 narrowly separated, club-shaped patches.

COLOR. The ground color above is deep seal-brown in an indistinct band which arises on the snout, widens to the full width of the head back of the eyes, continues along the trunk and on the tail nearly to the tip. Minute silvery-white and bronze specks are scattered over the entire dorsal surface. The ground color of the sides of the trunk and tail immediately below dorsal band, dark brown to bluish-black. Lower sides with many small, irregular, light blotches. Sides of head with many dull white blotches, more abundant back of the eyes, these spots continuous with those of the throat, where they are larger and more numerous, giving a mottled effect. Belly dark with small, scattered, bluish-white spots. The legs above are lighter brown than the dorsal band, below with a few light flecks.

Preserved specimens become uniformly purplish-brown above on the trunk and bluish-brown on the tail, the light dorsal markings fade and finally disappear, the light spots of the lower sides and venter remain.

BREEDING. Nothing has been published on the breeding habits of this species and the larvae are unknown. A large female in the Cornell University collection from Buckhannon, West Virginia, had 7 ovarian eggs,

each 3 mm. in diameter, but unfortunately the exact date of collection is lacking.

VAN DYKE'S SALAMANDER. WASHINGTON SALAMANDER. *Plethodon vandykei* Van Denburgh. Fig. 76. Map 31.

TYPE LOCALITY. Paradise Valley, Mt. Rainier Park, Washington.

RANGE. Western Washington; Coast, Olympic, and Cascade Mountains.

HABITAT. On June 21, 1936, we collected along the Calawah River, Washington, where small springs flowed from beneath overhanging banks covered by a tangle of vegetation. Here, among the small stones and gravel washed clean by the waters of the springs, we collected this salamander in company with *Plethodon vehiculum*, *Ascaphus truei*, and *Bufo boreas*. Slater (1933, p. 44) collected some specimens near Morton, Lewis County, Washington, from beneath moist slabs of bark at the base of a dead, giant Douglas fir, far from any stream. Other specimens collected by Slater were found under moist stones and moss near running water.

SIZE. The type specimen from Paradise Valley, Mt. Rainier Park, Washington, had a total length of 116 mm. and a tail length, measured from front of anus, of 56 mm. The proportions of an adult female from Forks, Washington, are as follows: total length $3\frac{25}{32}$ " (96 mm.), tail (tip damaged) $1\frac{3}{8}$ " (35 mm.); head length $\frac{9}{16}$ " (14 mm.), width $\frac{3}{8}$ " (9 mm.). A male has the following measurements: total length $3\frac{3}{8}$ " (85 mm.), tail $1\frac{1}{16}$ " (36 mm.); head length $\frac{1}{2}$ " (12.5 mm.), width $\frac{5}{16}$ " (7.5 mm.).

DESCRIPTION. This is one of the rarer species of *Plethodon* and is quite distinct in structural features from other members of the genus. Viewed from above, the head has the sides back of the eyes nearly parallel, the snout short and rapidly tapering. Parotoid glands rather prominently developed, in raised masses extending from the eyes along the dorso-lateral angles of the head to the lateral extensions of the gular fold. The

eyes are large and prominent, pupil horizontal, iris gilt and black. An impressed line extending from the posterior angle of the eye curves sharply down to the gular fold; a short curved line from this to the angle of the jaw and thence a short distance on either side of the throat.

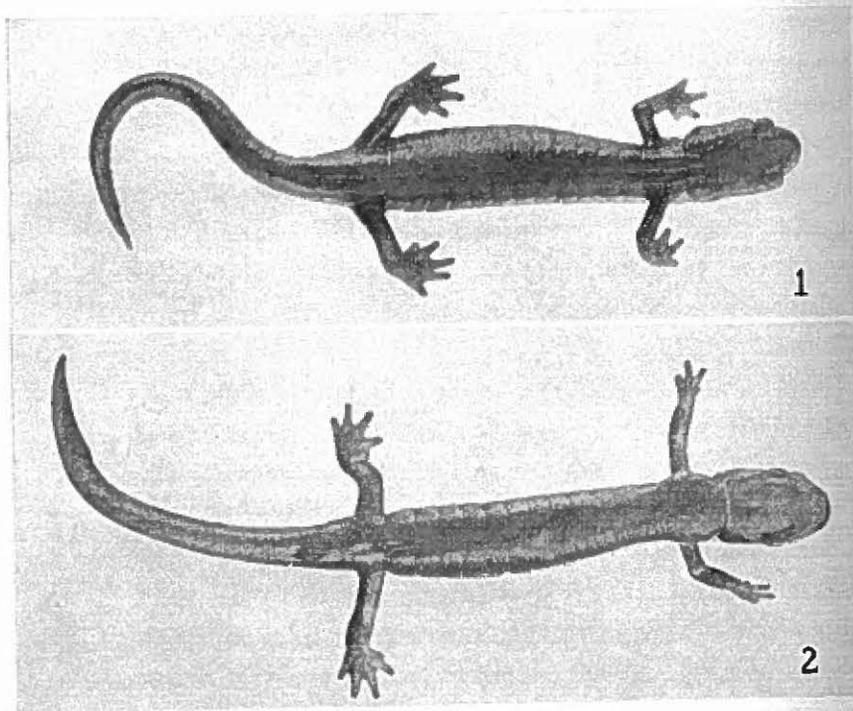


FIG. 76. *Plethodon vandykei* Van Denburgh. (1) Adult male, actual length $3\frac{5}{16}$ " (84 mm.). (2) Same, ventral view. Forks, Washington.

The trunk in cross section is wider below than above and with the sides slightly rounded to the somewhat flattened dorsum. There is a slight, impressed, median dorsal line extending from the back of the head to the base of the tail. The tail is roughly oval in section at the base, compressed and rather abruptly tapering to the tip. Costal grooves 13-14, the usual number 14 when 1 each is counted in axilla and groin; 2-3 intercostal spaces between toes of appressed limbs. Legs rather short

and stout, the hind proportionally larger than in most species of *Plethodon*. Toes 5-4, those of the hind feet 1-5-2-4-3 in order of length from the shortest, strongly webbed at base; toes of fore feet 1-4-2-3, the innermost rudimentary and entirely within the web. Tongue moderate, bluntly pointed at tip, widest behind, the sides free, thin, and smooth. Vomerine teeth 10-10 in an adult female, the series arising behind the center of the inner nares and curving inward and sharply backward toward the middle line, where they are separated by about the width of an inner naris. In an adult male, the vomerine teeth 10-11, forming rather irregular series extending nearly to the mid-line and only narrowly separated from the parasphenoids. The parasphenoid teeth in 2 narrowly separated club-shaped patches in the female, less evidently separated in the male.

COLOR. This species is marked above by a broad median stripe which extends from the head to the tip of the tail. On the head and trunk the band is brownish-yellow, on the tail decidedly lighter and more yellowish. The sides below the dorsal band are a slightly darker brown, the color involving the sides of the head, the sides of the trunk to the level of a line passing through the legs, the dorsal surface of the legs, and the upper sides of the tail. Below the dark sides, the light color of the venter is visible up to the mid-line of the legs. The venter in some individuals is a very light flesh color, in others lightly mottled with pale brown. Throat and distal half of the tail beneath yellow. In younger specimens the dorsal stripe is sometimes brownish-yellow on the head, yellow tinged with greenish on the trunk, and bright orange-yellow on the tail. In these the sides of the trunk are Mummy Brown (Ridgway) flecked with white below, the sides of the head mottled with brown blotches and white flecks. Legs above brown, mottled with yellowish-white. The throat is light, yellowish, and with a few scattered blotches around the margins. The belly is brownish, lighter than the sides, and flecked with white.

BREEDING. Noble (1925, p. 6) remarks: "Mr. Phillips Putnam has sent

me a cluster of eggs of this species which he found fastened together in a grape-like mass and attached to the stone by a string of elastic material. The stone was in a damp situation and covered by moss."

WESTERN RED-BACKED SALAMANDER. *Plethodon vehiculum* (Cooper). Fig. 77. Map 32.

TYPE LOCALITY. Astoria, Oregon.

RANGE. Western Oregon, Washington, and British Columbia including Vancouver Island.

HABITAT. Found beneath logs, bark, stones, and moss, in cool, damp, and shaded ravines. Common in the Douglas-fir forests near Portland, Oregon. In the Green River Gorge near Seattle, Washington, we collected many specimens from beneath stones and logs on the steep sides of the ravine and among the loose stones at the foot of the cliff bordering the river.

SIZE. The largest specimen, a female, measured by Dunn (1926, p. 155) had a total length of 105 mm. and a tail length of 43 mm. In a large series from Washington and Oregon the largest specimens measured were females. Measurements of a female from Skokomish River near Shelton, Oregon, are as follows: total length $4\frac{5}{32}$ " (105 mm.); tail $1\frac{3}{32}$ " (50 mm.); head length $1\frac{5}{32}$ " (12 mm.), width $\frac{5}{16}$ " (8 mm.). An adult male from near Forks, Washington, measures as follows: total length $3\frac{5}{8}$ " (92 mm.), tail $1\frac{3}{4}$ " (45 mm.); head length $1\frac{3}{32}$ " (10 mm.), width $\frac{3}{32}$ " (7 mm.). My smallest specimen is 32 mm. in total length, of which the tail comprises only 10.5 mm.

DESCRIPTION. This species resembles the eastern *Plethodon cinereus*, but is a more active species, attains a somewhat larger size, and has a stouter body and stronger limbs. The head has the sides nearly parallel back of the eyes, in front converging to the bluntly pointed snout. Eyes moderate but strongly protuberant; posterior corner of eye with a vertical flap under which both eyelids slip. A prominent gular fold; a deep sinuous groove from the posterior corner of eye to the lateral extensions of gular fold; a short deep groove from this to angle of jaw. Trunk

moderately stout, well rounded, often slightly depressed above and with a slight median dorsal groove. Tail thick, fleshy, subquadrate in section near base, slightly tapering $\frac{3}{4}$ of its length, then quite abruptly

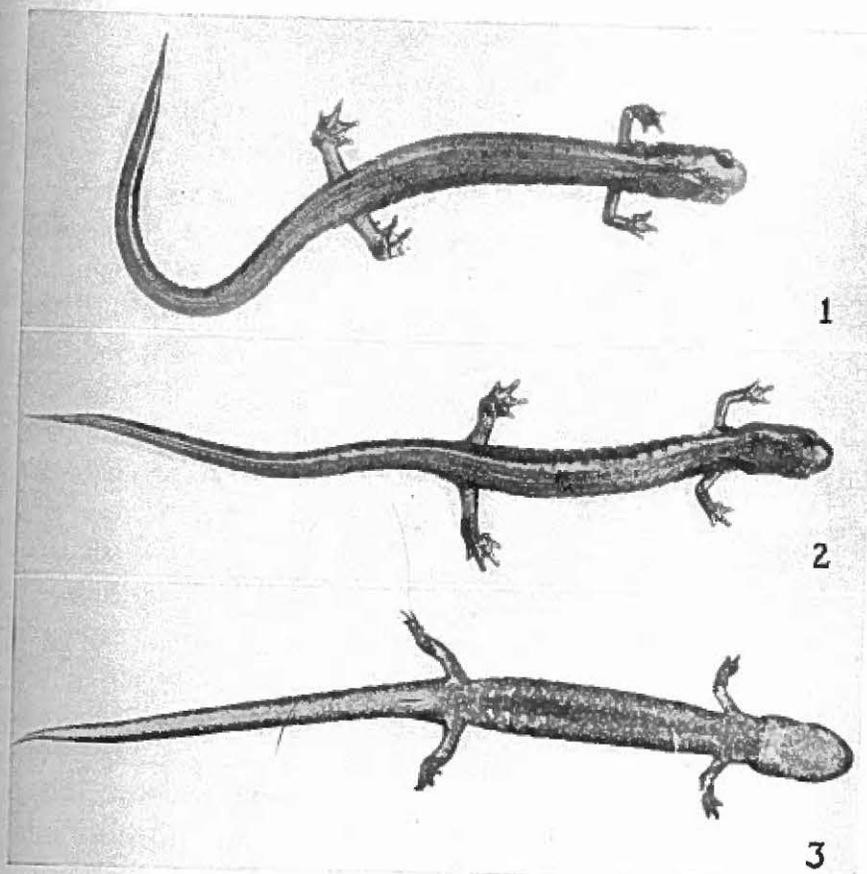


FIG. 77. *Plethodon vehiculum* (Cooper). (1) Adult female, dark phase; actual length $4\frac{1}{8}$ " (105 mm.). (2) Adult male, light phase; actual length $3\frac{13}{16}$ " (97 mm.). (3) Adult female, ventral view; actual length $4\frac{1}{8}$ " (103 mm.). Portland, Oregon.

to the pointed tip. Usually 15 costal grooves, counting 1 each in axilla and groin, rarely 16, or 15 on one side and 16 on the other; 5-6 intercostal spaces between toes of the appressed limbs. Legs fairly stout; toes 5-4, those of the hind feet 1-5-2-3-4 in order of length from the

shortest, slightly webbed at base; toes of the fore feet, 1-4-2-3, the innermost rudimentary. Basal joints of legs above colored like the dorsal band. Lower legs and feet above usually colored like the side of trunk. Tongue fairly large and filling the floor of the mouth. Vomerine teeth 5-7, usually 6, the short series beginning behind inner edge of nares and curving inward and backward, separated by about the width of an inner naris and from the parasphenoid by a little more. Parasphenoids in 2 large, incompletely separated, club-shaped patches.

COLOR. The majority of specimens have a dorsal band which varies in color from dull, dirty white to light yellowish-red, dusky red, orange-red, bright red to deep brownish-red suffused with dusky. In some the band may be strongly flecked with black, in others almost obliterated, leaving only a very narrow lighter line on each side to indicate its limits. Young individuals may have the dorsal band a bright, clear orange-red without darker markings, or be uniformly dull pinkish-gray. The band may originate on the shoulders and continue to the tip of the tail, or the whole dorsal surface of the head may be involved. Upper sides darkest next to the band, fading gradually into the brownish sides, which are mottled with white. Venter, in life, definitely flecked with small white spots on a bluish ground color, throat lighter, dusky yellowish. The superficial white flecks on the sides and venter give a characteristic pepper-and-salt effect and apparently overlie the black chromatophores. The interspaces between them are sometimes quite yellow, particularly on the throat, sides of the vent, and lower surface of the basal third of the tail. In preserved specimens the red normally fades so that the dorsal band is usually tan or dull yellow and the sides brownish or bluish, with dull yellow interspaces. The superficial white fleckings disappear entirely on the sides and venter, the latter becoming grayish mottled with yellow.

SEXUAL DIFFERENCES. The sexes of adults may be distinguished by the shape of the lower jaw, which in the female is broadly rounded in front and in the male slightly pointed; or by the vent, which in the female has the sides thrown into narrow oblique folds, while in the male the

sides are bordered by a depressed flange-like ridge broken by a few narrow cross lines and produced behind into free flaps.

BREEDING. Little is known of the breeding habits. Slevin (1928, p. 55) records that "a female collected near the Hoh River, Jefferson County, Washington, on September 20, 1919, contained eggs about two and one-half millimeters in diameter." In large females which we collected June 20, 1936, near Shelton, Washington, there were a few eggs 2 mm. in diameter and many small ones. Specimens taken in February at Portland, Oregon, had only small ovarian eggs. The larvae have not been described.

WEHRLE'S SALAMANDER. *Plethodon wehrlei* Fowler and Dunn. Fig. 78. Map. 35.

TYPE LOCALITY. Two Lick Hills, Indiana County, Pennsylvania.

RANGE. Southwestern New York, western Pennsylvania, West Virginia, and southeastern Ohio.

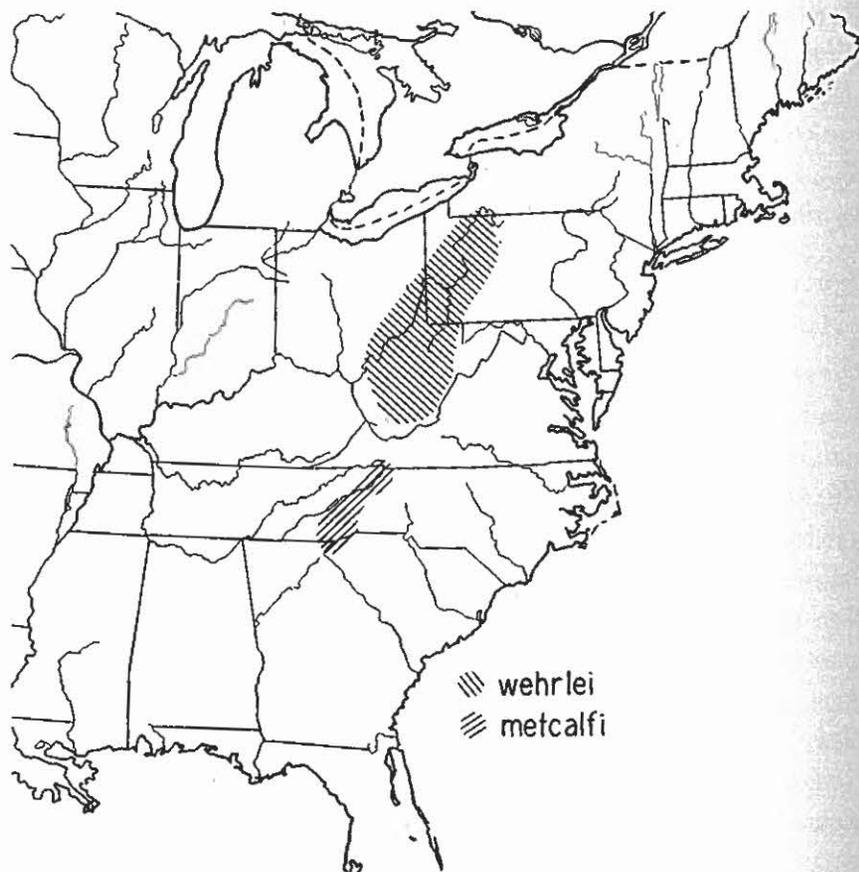
HABITAT. This species is commonly found on wooded hillsides, where it hides by day beneath stones or rocks; less frequently under or within old rotting logs. The majority of the specimens I have collected have been under flat stones in old second-growth, mixed deciduous and evergreen woods. Netting (1932, p. 6) found the species in West Virginia, in cave entrances, in deep rock crevices, and near "ice caves." In New York State the species is more commonly associated with *Plethodon cinereus* than with *P. glutinosus*, the latter apparently requiring more moisture.

SIZE. Large females reach a length of 6" (152 mm.). My largest male, from Allegany State Park, New York, has a total length of 5⁵/₁₆" (135 mm.), tail 2³/₄" (70 mm.); head length ⁵/₈" (15 mm.), width ³/₈" (9 mm.). The proportions of an adult female from Port Allegany, Pennsylvania, are as follows: total length 4¹⁵/₁₆" (122 mm.), tail 2¹/₁₆" (65 mm.); head length ⁹/₁₆" (13.5 mm.), width ⁵/₁₆" (7.5 mm.).

DESCRIPTION. This is a slender species related to and somewhat resembling the Slimy salamander, *P. glutinosus*. Differs from *P. glutinosus*

in its more slender form, in having the light spots usually restricted to the sides, and in having a higher costal-groove count.

The head is broadly oval in outline, widest just back of the eyes, tapering slightly posteriorly, and abruptly to the bluntly pointed and de-



MAP 35.—Distribution of *Plethodon wehrlei* and *P. metcalfi*.

pressed snout. The eyes are prominent, with the pupil black and the iris deep brown. Eyelids limited behind by a short vertical groove. Gular fold prominent and extending well on the sides of the neck. A deep sinuous groove from the eye to the lateral extensions of the gular fold, and a short vertical groove from this line to the angle of the jaw. Trunk

slender, rounded, and with a median impressed line from the back of the head to the base of the tail. Costal grooves 16-17, the usual number 16 when 1 each is counted in the axilla and groin; 2-3 intercostal spaces

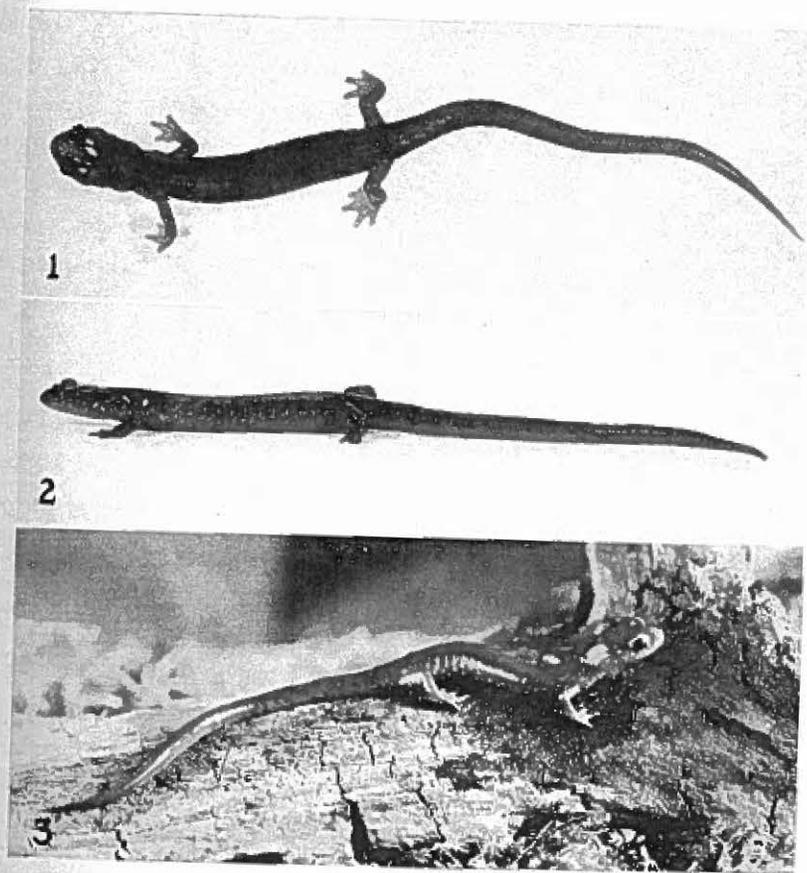


FIG. 78. *Plethodon wehrlei* Fowler and Dunn. (1) Adult male, actual length $5\frac{5}{16}$ " (135 mm.). (2) Same, lateral view. Allegany State Park, New York. (3) Adult female. Port Allegany, Pennsylvania.

between the toes of the appressed limbs. Tail slender, nearly circular in cross section at base, evenly tapering to the tip, which may be slightly compressed in some individuals. Legs well developed. Toes 5-4, those of the hind feet 1-5-2-3-4 or 4-3 in order of length from the shortest,

short, blunt-tipped, 1st webbed nearly to the tip, others at base; toes of front feet, 1-4-2-3, the 1st rudimentary and webbed nearly to tip, others at base. Tongue broad and flat and nearly fills the floor of the mouth. Vomerine teeth 6-8 in each series in the male and 7-9 in the female. The series arise behind the outer margin of the inner nares and curve inward and gently backward toward the mid-line, where they are separated by about the diameter of a naris. Parasphenoid teeth in 2 well separated, slender, club-shaped patches, usually distant from the vomerine teeth by about the diameter of a naris, more rarely continuous with the vomerine series on either or both sides.

COLOR. The color in life is somewhat variable. The general impression is that of a black salamander with pale spots on the sides. In some individuals the ground color above is a deep brown, almost black, except on the head, where the brown may be a little lighter. The lower sides may be bluish-brown flecked with irregular whitish spots and dashes. The legs are usually colored above like the dorsal surface of the head and have a few light fleckings. The belly and lower surface of the tail uniformly light gray, the throat conspicuously lighter and often mottled. The lower surface of the legs and feet often with tinges of flesh. In some specimens the general color has bluish-black reflections, and the light markings of the sides are carried well on the back and sides of the head below the eyes. Dunn (1926, p. 135) writes that some young individuals have paired red spots on the back. His smallest specimen was 44 mm. in total length. I have collected a single specimen only 37 mm. long and several others only slightly longer, but in none has there been the slightest evidence of dorsal red spots.

SEXUAL DIFFERENCES. Sexual differences are not very strongly marked. Some adult males have a small mental gland, and the sides of the vent are thrown into narrow ridges. The vent of the female is a simple slit with smooth margins.

BREEDING. Little is known of the breeding habits. Ovarian eggs of females taken in June in New York State are very small, so it is likely that in this section egg-laying takes place later in the summer.

WELLER'S SALAMANDER. *Plethodon welleri* Walker. Fig. 79. Map 34.

TYPE LOCALITY. Grandfather Mountain, near Linville, North Carolina.

RANGE. Grandfather Mountain, North Carolina, above 5000', and Whitetop Mountain, Virginia.

HABITAT. Generally found beneath logs, stones, and flakes of rock, in the spruce forests covering the higher slopes of the mountains. On April 19, 1938, U. B. Stone, Robert Van Auken and I collected along the trail leading to the summit of Grandfather Mountain and took many specimens within a few feet of the path.

SIZE. This is a small species, the adults attaining a length of a little more than 3". The proportions of a female from Grandfather Mountain, North Carolina, taken April 19, 1938, are as follows: total length $3\frac{1}{16}$ " (77.5 mm.), tail (tip lost) $1\frac{5}{16}$ " (33 mm.); head length $1\frac{3}{32}$ " (10.5 mm.), width $\frac{1}{4}$ " (6 mm.). A male of the same length from the same locality has the tail $1\frac{1}{4}$ " (32 mm.); head length $\frac{3}{8}$ " (10 mm.), width $\frac{1}{4}$ " (6 mm.).

DESCRIPTION. In the form of the body there is a general resemblance to a small *Plethodon cinereus*. Head widest at the angle of the jaws, converging slightly behind to the lateral extensions of the gular fold, the snout short and blunt, the tip truncated and slightly overhanging the lower jaws. The eyes are of moderate size, noticeably smaller than in *P. yonahlossee* of the same size, and with the iris only slightly flecked with brassy. A deep sinuous line from the posterior angle of the eye to the lateral extensions of the gular fold; a short curved groove from this line to the angle of the mouth. The trunk is rounded on the sides, flattened beneath, and with an impressed median dorsal line from the head to the base of the tail. The tail is slender and tapers evenly to the tip, nearly circular in cross section at the base, oval distally. Costal grooves 16, counting 1 each in axilla and groin; 3-4 intercostal spaces between toes of appressed limbs. Legs small, slender, toes 5-4, those of the hind feet 1-5-2-4-3 in order of length from the shortest, the innermost rudimentary and webbed nearly to the tip, the others webbed at base; toes

of the fore feet 1-4-2-3. Tongue broad and flat, nearly filling the floor of the mouth. Vomerine series short, each with 4-6 teeth, the series arising behind the outer margin of the inner nares and extending obliquely inward and backward, separated at the mid-line by about

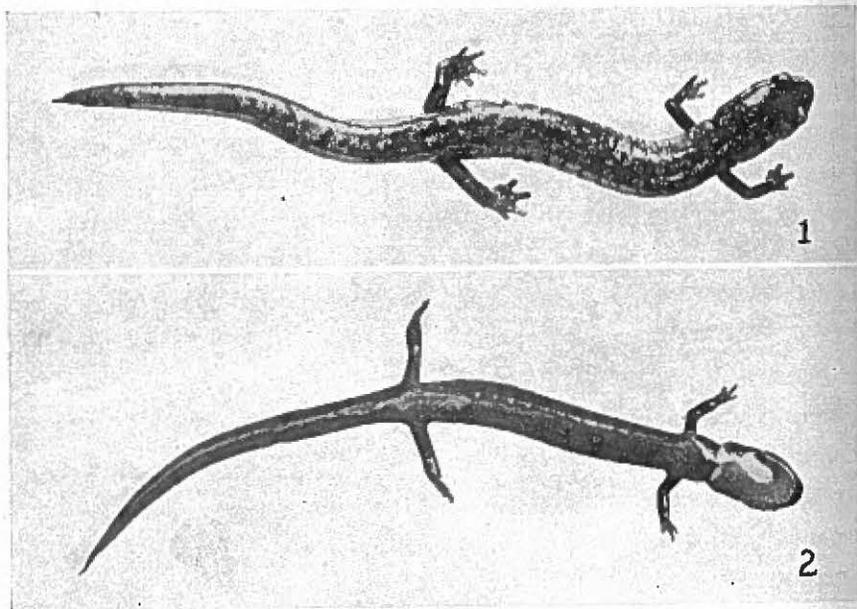


FIG. 79. *Plethodon welleri* Walker. (1) Adult female, actual length $3\frac{5}{16}$ " (75 mm.). (2) Same, ventral view. Grandfather Mountain, North Carolina.

twice the diameter of an inner naris. Parasphenoid teeth in 2 elongate club-shaped patches, widely separated from the vomerine.

COLOR. The ground color above is black, with the dorsal surfaces of the head, trunk, and tail with a broad irregular band formed by numerous dull golden blotches. In some individuals the blotches are aggregated along either side of the median line, in other more generally distributed. A few golden flecks extend down on the sides between the costal grooves, but the sides are mostly black, with a few small whitish flecks near the sides of the belly. The belly is slate with purplish reflections, sometimes with a few scattered light spots; the ventral

surface of the tail darker than the belly and the throat lighter, a dull, dirty grayish-white. The lower surface of the legs is colored like the throat, with nearly white spots marking the joints. In preservative, the golden flecks disappear entirely and the ground color above becomes uniformly slate, the belly grayish-blue, the throat and lower surface of the legs grayish-white. A few pale spots may persist along the lower sides and on the sides of the belly.

SEXUAL DIFFERENCES. The sexes may be distinguished by the form of the vent, which is larger in the male and produced behind into 2 flat lobes; in the female it is a simple slit. Adult males have a poorly defined mental gland, the tip of the lower jaw is slightly more pointed, and the snout is swollen at the ends of the nasolabial grooves.

BREEDING. Nothing has been published concerning the breeding behavior.

YONAHLOSSEE SALAMANDER. *Plethodon yonahlossee* Dunn. Fig. 80. Map 30.

TYPE LOCALITY. Near the Yonahlossee Road, about $1\frac{1}{2}$ miles from Linville, North Carolina.

RANGE. Blue Ridge Mountains in western North Carolina and in southwestern Virginia.

HABITAT. These salamanders have been taken between 3200' and 5000' elevation on the wooded slopes of the mountains, where they hide by day beneath logs and stones or occasionally beneath the bark of a rotted log. Dunn (1926, p. 133) writes, "They have long burrows in the floor of the forest, whose openings are usually under a fallen log or piece of bark." Bailey (1937, p. 3) found that this species could be most easily collected at night by means of a headlamp. *P. yonahlossee* is associated in nature with *Plethodon glutinosus*, *P. cinereus*, and *P. metcalfi*, but is rarer than any of these and much more restricted altitudinally.

SIZE. This is one of the larger species of *Plethodon*, adults attaining an extreme length of $6\frac{1}{2}$ " (165 mm.). The measurements of the type, a moderate-sized individual, given by Dunn (1926, p. 132), are as fol-

lows: total length $5\frac{1}{2}$ " (140 mm.), tail $2\frac{1}{2}$ " (63 mm.); head length $1\frac{1}{16}$ " (17 mm.).

DESCRIPTION. This species is related to *Plethodon glutinosus*, *P. wehrlei*, and *P. ouachitae*. Of these only the last named has a chestnut-colored

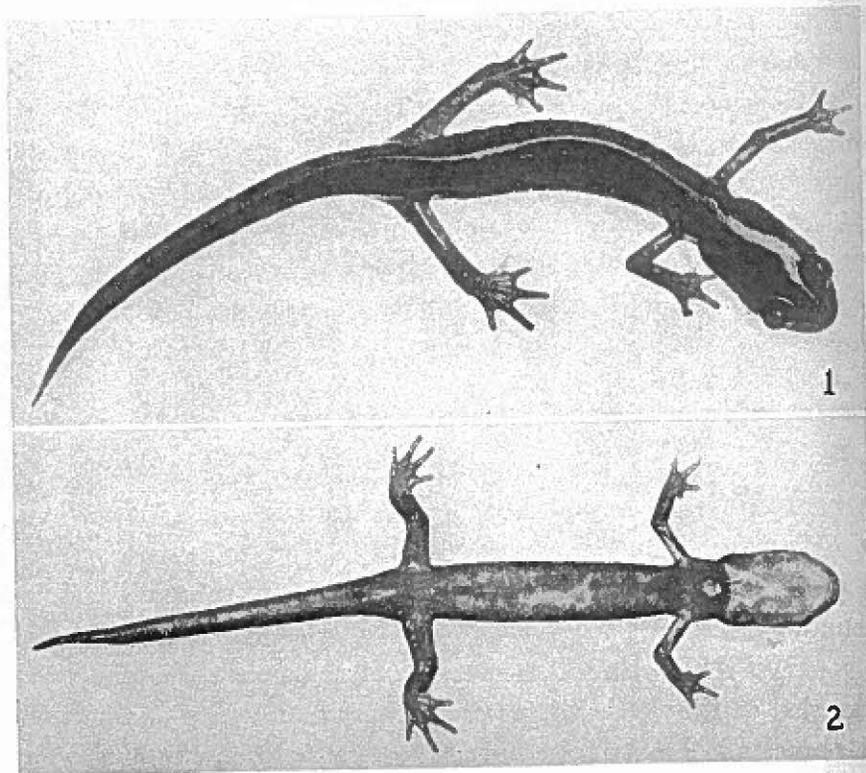


FIG. 80. *Plethodon yonahlossee* Dunn. (1) Juvenile female, actual length $2\frac{15}{16}$ " (74 mm.). (2) Same, ventral view [photograph after preservation]. Near Linville, North Carolina.

band, all have whitish blotches on the sides or back, or on both areas. The head is widest at the eyes, converging slightly behind; the snout is short, the sides converging abruptly to the bluntly rounded tip. The eyes are large, strongly protuberant, and with the iris black; the eyelids limited behind by a crescentic fold. An impressed line from the eye to the lateral

extension of the gular fold; a short curved groove from this line to the angle of the jaw. The trunk is well rounded on the sides and above, below flattened. The tail is subquadrate in section at the base, oval in section at about $\frac{1}{2}$ its length, slightly compressed distally. Costal grooves 15, counting 1 each in the axilla and groin. In some individuals 2 grooves run together in the groin, and if both are counted the number is 16. In half-grown specimens the appressed toes may meet, in larger individuals they may be separated by an intercostal space. The legs are moderately stout, toes 5-4, those of the hind feet 1-5-2-3-4 or 4-3 in order of length from the shortest, the innermost webbed nearly to the tip, the others at base; toes of the fore feet 1-4-2-3, the 2nd and 4th nearly equal. Tongue rather broad and flat, the margins thin and smooth, the plicae radiating from the posterior field. Vomerine series long, originating outside and behind inner nares and curving inward and backward, separated by about the width of an inner naris. Teeth variable in number from 10 to 14 in each series in specimens I have examined. Dunn (1926, p. 130) records 17. Parasphenoid teeth in a single broad club-shaped patch.

COLOR. In life the ground color above is dark gray, almost black. A broad median chestnut-red band extends from the back of the head to the base of the tail; the band also with lateral extensions running down the sides between the costal grooves nearly to the level of the legs. Sides below the dorsal band gray, blotched strongly but irregularly with whitish spots. Sides of head and tail also with white blotches. Dorsal surface of the tail dark gray, almost black, and with only a few small light flecks. Fore legs light gray with a few small light spots, hind legs darker gray, lightly flecked; toes flesh color. The belly is bluish-gray, the ventral surface of the tail slightly darker, the throat lighter, pale dirty white. In young specimens, $2\frac{1}{2}$ " long or less in total length, there is frequently a double series of dorsal spots brighter red than the adjacent band because of the absence in them of black pigment.

Specimens long in preservatives lose the chestnut color almost entirely; the back becomes uniformly dull brownish or bluish-black, the

venter grayish or brownish mottled and blotched with lighter areas, and the legs brown or tan. The light blotches of the sides persist but are duller than in life.

BREEDING. Nothing is known of the breeding habits of this species.

GENUS PLETHOPSIS

WESTERN FOUR-TOED SALAMANDER. *Plethopsis wrighti* Bishop. Fig. 81.

Map 53.

TYPE LOCALITY. 8.7 miles southeast of Sandy, Clackamas County, Oregon.

RANGE. KNOWN from the vicinity of the type locality, from near the mouth of Moose Creek and Middle Santiam River, Linn County, and from Cherryville, Clackamas County, Oregon.

HABITAT. Discovered on the wooded slopes bordering the Mount Hood highway, the forest consisting of mixed deciduous and evergreen trees, an undergrowth of shrubs, and a ground cover of moss and low herbs. Individuals were found beneath the bark of rotted logs, under chips and logs on the ground, and between pieces of bark piled in a heap at the base of a stump.

SIZE. In the type series, the adult males varied from $3\frac{3}{16}$ " (91 mm.) to $3\frac{1}{16}$ " (97 mm.), the females from $3\frac{5}{16}$ " (84 mm.) to $3\frac{3}{4}$ " (95 mm.). Other individuals of both sexes were mature at sizes less than those indicated above, but loss of portions of the tail made determination of total length impossible. The proportions of a male are as follows: total length $3\frac{1}{16}$ " (97 mm.), tail 2" (51 mm.); head length $\frac{3}{8}$ " (9 mm.), width $\frac{1}{2}$ " (5.5 mm.). Female, total length $2\frac{7}{32}$ " (72 mm.), tail $1\frac{1}{4}$ " (32 mm.); head length $\frac{5}{16}$ " (8.5 mm.), width $\frac{3}{16}$ " (5 mm.).

DESCRIPTION. This genus is related to *Plethodon* but differs in several well marked structural characteristics. It is a slender species of moderate size, the head widest immediately behind the eyes, the sides converging slightly to the lateral extension of the gular fold and in front rather abruptly to the short blunt snout. The eyes are prominent, the

lids limited posteriorly by an oblique fold. An impressed sinuous line from the posterior angle of the eye to the lateral extensions of the gular

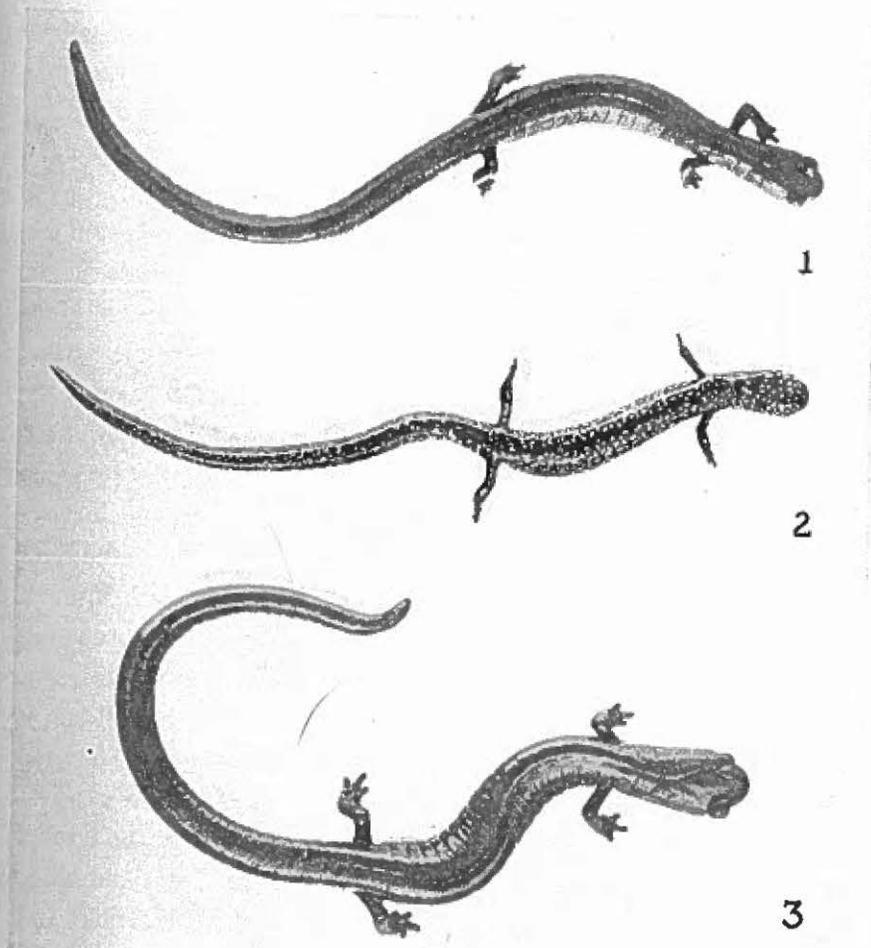


FIG. 81. *Plethopsis wrighti* Bishop. (1) Adult male, actual length $3\frac{1}{16}$ " (97 mm.). (2) Same, ventral view. (3) Another individual to show the four toes on both fore and hind feet. Paratypes from 8.7 miles southeast of Sandy, Oregon.

fold; a poorly defined vertical groove from this line passing back of the angle of the jaw. The trunk is well rounded on the sides and above, flattened ventrally, and with an impressed median line from the head

to the base of the tail. Tail subquadrate in section near the base, slightly compressed distally. Costal grooves 16 or 17, counting 1 each in the axilla and groin; rarely with 16 on one side and 17 on the other; $6\frac{1}{2}$ -7 intercostal spaces between the toes of the appressed limbs. Legs rather small and slender, toes 4-4, 1-4-2-3 in order of length from the shortest, the innermost rudimentary and webbed to tip, the others webbed $\frac{1}{2}$ their length. Tongue small, attached by a central pedicel and by a ligament in front. Vomerine series long, in the male each usually 12-15, the series originating behind the outer margin of the inner nares; in the female usually 10-14, the series originating behind the middle of the inner nares. Parasphenoid teeth in 2 long, narrowly separated, club-shaped patches. In 10 of a series of 20 specimens the vomerine and parasphenoid series are separate, in 3 males and 1 female the series are continuous on both sides, and in 1 male and 5 females the series are continuous on one side and slightly separated on the other.

COLOR. In life this species has a conspicuous dorsal band which varies in color from chestnut to reddish-brown. In a few individuals the band is reddish-brown along the margins and blotched with black through the center. Two of the largest individuals have the band dull brownish-yellow. In some the band is strongly suffused with dusky on the snout and trunk. The band is brightest on the basal half of the tail and is usually irregularly invaded with black on the posterior half. The band originates on the snout and involves the entire width of the head including the eyes, and extends along the trunk well above the level of the legs. The lateral margins of the band may be nearly straight, but in some individuals are irregular and broken. The upper sides, where they border the dorsal band, are deep brown or black to the level of the legs, below which the sides are heavily flecked with many small, irregular, bluish-white spots on a slate ground color; the belly is dark slate to almost black, conspicuously flecked with bluish-white, the middle line only being relatively free; upper surface of legs dark with small light spots. The throat, venter of the tail, and lower surface of the legs strongly flecked with lighter spots.

SEXUAL DIFFERENCES. The sexes may be distinguished by the form of the vent, which in the female is a simple slit; in the male it is bordered by a narrow depressed area and the lips are thrown into folds.

BREEDING. Nothing is known of the breeding habits of this species.

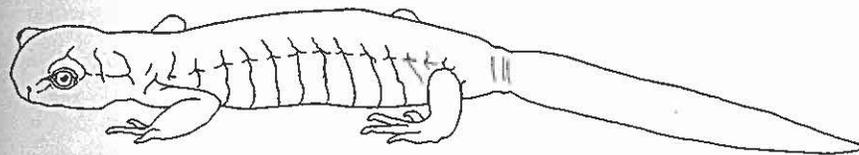
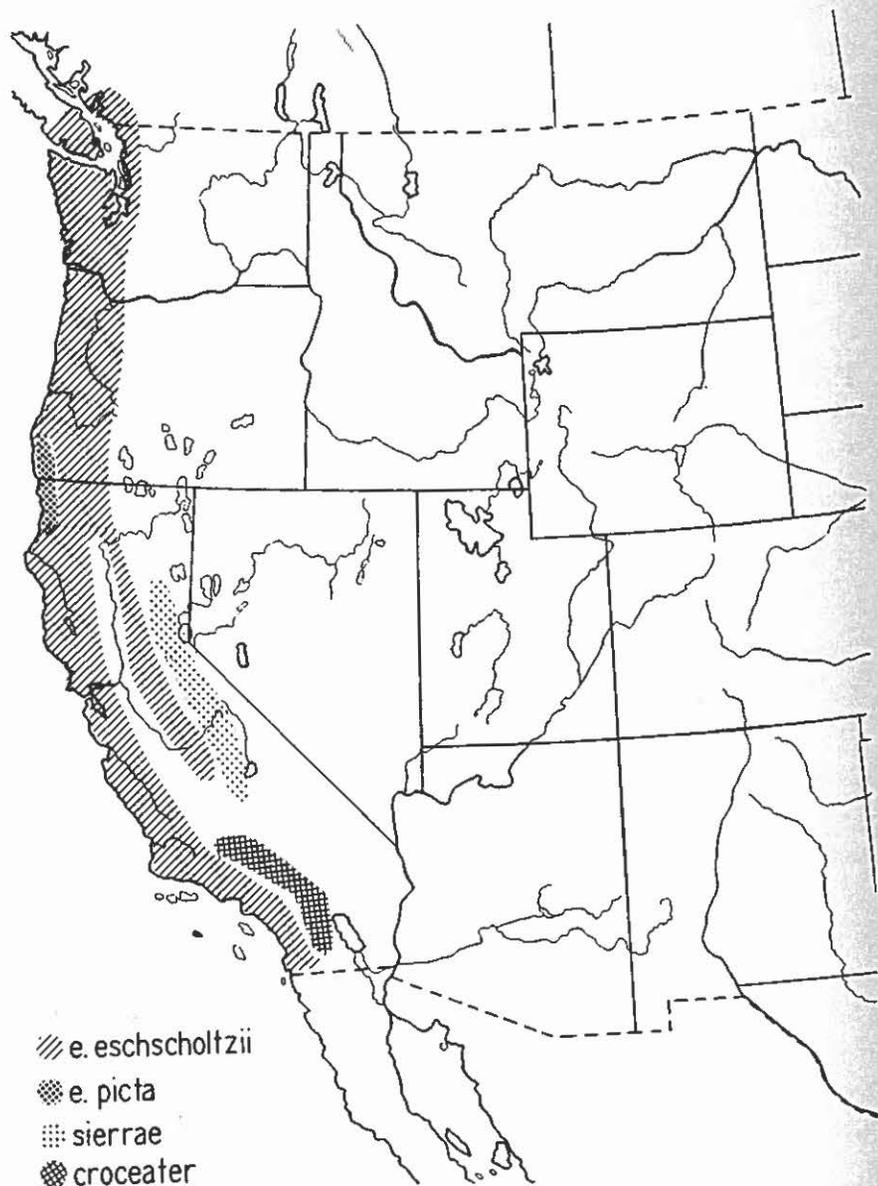


FIG. 82. Outline of *Ensatina e. eschscholtzii* to show the general body form and tail constriction. Tail shorter than normal. [Drawn by Hugh P. Chrisp.]

GENUS ENSATINA

KEY TO THE SPECIES AND SUBSPECIES OF ENSATINA

1. Dorsal color deep brown to black, with blotches, spots, or patches of orange or orange-yellow 2
Dorsal color not as above 3
2. Dorsal blotches large, those of the trunk often confluent at mid-line above, sometimes alternating; tail from above broadly barred; legs mostly orange, dark near feet; length to $5\frac{1}{8}$ " (150 mm.). From Kern and San Diego Counties, California; also reported from Lower California *croceater* p. 295
Dorsal blotches very irregular, lichen-like, on the trunk mostly confined to the sides; tail strongly blotched but seldom with appearance of being barred; basal segments of legs orange, distal segments blotched with gray and orange; length to $5\frac{3}{32}$ " (131 mm.). Sierra Nevada from Butte to Tulare Counties, California *sierra* p. 303
3. Uniformly yellowish-brown to light reddish-brown above; belly flesh color; length to $5\frac{1}{16}$ " (135 mm.). From British Columbia and Vancouver Island south to southern California, west of the Sierras and Cascades *eschscholtzii eschscholtzii* p. 297
Above light reddish-brown, with a dorsolateral series of irregular, deep brown or blackish marks, and usually with an interrupted middorsal black line; tail strongly blotched above; belly and ventral surface of legs yellowish; length to $4\frac{3}{32}$ " (104 mm.). From Humboldt County, California, northward through Del Norte County at least to Port Orford, Curry County, Oregon *eschscholtzii picta* p. 300



MAP 36.—Distribution of the subspecies of *Ensatina eschscholtzii*, *E. sierrae*, and *E. croceater*.

YELLOW BLOTCHED SALAMANDER, YELLOW SPOTTED SALAMANDER. *Ensatina croceater* (Cope). Fig. 83. Map 36.

TYPE LOCALITY. Fort Tejon, California.

RANGE. From Kern to San Diego Counties, southwestern California; also recorded from Lower California but probably erroneously.

HABITAT. This is a mountain species, having usually been taken at elevations above 4000'. Generally found in or beneath rotting logs or in leaf mold; occasionally abroad at night during rains.

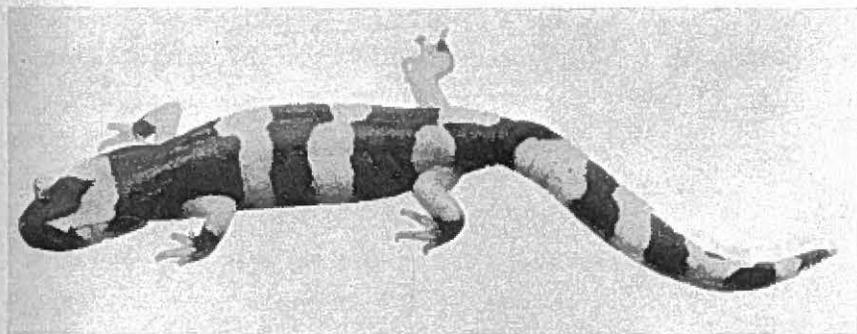


FIG. 83. *Ensatina croceater* (Cope). Adult. San Diego County, California. [Photograph through the courtesy of L. M. Klauber.]

SIZE. This is the largest species of the genus, full-grown individuals reaching an extreme length of about $5\frac{7}{8}$ " (150 mm.). The average length of 18 adults of both sexes from San Diego County, California, is $4\frac{1}{4}$ " (108.5 mm.), the extremes $3\frac{5}{32}$ " (80 mm.) and $5\frac{15}{32}$ " (140 mm.). The proportions of an adult male from Pine Hills, San Diego County, California, are as follows: total length $4\frac{25}{32}$ " (122 mm.), tail $2\frac{1}{32}$ " (61 mm.); head length $1\frac{1}{16}$ " (18 mm.), width $\frac{7}{16}$ " (11 mm.). A female from Cuyamaca, California, measures: total length $4\frac{13}{16}$ " (123 mm.), tail $2\frac{5}{32}$ " (55 mm.); head length $2\frac{5}{32}$ " (20 mm.), width $1\frac{5}{32}$ " (12 mm.).

DESCRIPTION. A vivid black-and-orange-blotched salamander with a definite tail constriction. The head is large, the sides behind the eyes nearly parallel or slightly narrowing to the gular fold; in front con-

verging to the bluntly pointed snout. Eyes large and strongly protuberant, the pupil horizontally elliptic. A deep groove from the posterior angle of the eye to the lateral extension of the gular fold; a short vertical groove from this line passing behind the angle of the jaw. Trunk stout, above with an impressed median line. Usually 12 costal grooves, counting 1 each in the axilla and groin, occasionally 13; the toes of the appressed limbs overlapping 1 or 2 (in young) to $5\frac{1}{2}$ intercostal folds. Tail stout and with a well marked constriction immediately behind the vent; broadly oval in section at base, widest and deepest at about the basal third, slightly compressed below, rounded above and tapering rather abruptly to a sharp point. The tail comprises 32.5-35.4 per cent of the total length in juveniles 43 and 62 mm. long respectively, 42.3-44.8 per cent in the females, and 45.1-52.2 per cent in the males, the length increasing with age. Legs stout, the hind noticeably larger than the fore. Toes 5-4, moderately slender and evenly tapering, those of the hind feet 1-5-2-3-4 in order of length from the shortest; toes of the fore feet 1-4-2-3. Tongue obovate, free behind and at the sides. Vomerine teeth in 2 very long, strongly arched series that arise well outside the outer margin of the inner nares, curve forward, then inward and backward, nearly meeting at the mid-line. In a series of 18 adults, the teeth average 26.58, the extremes 16 and 32. In juvenile specimens 43 and 45 mm. long, the teeth 8-8 and 10-8 respectively. Parasphenoid teeth in 2 narrowly separated, club-shaped patches distant from the vomerine by about 3 times the diameter of an inner naris.

COLOR. The color in life as described by Klauber (1927, p. 4) is as follows: "Dorsal color black, fading on the sides to Dusky Purplish Gray (Ridgway). The irregular series of dorsal blotches (one on the head engaging the eyelids, four on the body, four on the tail) are Orange Rufous; under surfaces transparent Light Vinaceous Lilac. The legs are of the same color as the dorsal blotches except the extremities, which are similar to the under surfaces." In a fine series of 23 specimens from San Diego County, California, loaned by Mr. L. M. Klauber, there is some variation in the number and disposition of the orange blotches.

Often there is a U-shaped mark on the dorsum of the head which involves the eyes and sends a broad branch down on each side of the head back of the angle of the mouth; frequently this blotch is broken at the mid-line above. The blotches on the trunk may be more or less rounded and separated, but usually form pairs in contact at the mid-line and set diagonally. Sometimes 2 or 3 pairs of blotches meet at the mid-line of the back nearly opposite one another, others are offset so that only the anterior corner of one is in contact with the posterior corner of another. The tail often has the appearance of being completely ringed when seen from above; or the blotches may be arranged alternately on either side of the mid-line.

SEXUAL DIFFERENCES. The sexes may usually be separated by the form of the vent, which in the male is larger and more strongly protuberant and has the margins grooved. The snout of the male is sometimes swollen at the nasolabial grooves, which are split distally (Y-shaped), the stem running to the nostril, one branch toward the mid-line of the upper lip, the other diagonally toward the side.

BREEDING. Nothing has been reported concerning the breeding habits. The eggs are known from a set of 14 collected by Mr. L. M. Klauber July 25, 1927, near Julian, California, and reported by Storer (1929, p. 447). The eggs were accompanied by an adult and adhered to one another, but were without evidence of a stalk. "Individually they were about five-sixteenths of an inch in diameter, yellowish in color, and opaque."

RED SALAMANDER. OREGON SALAMANDER. *Ensatina eschscholtzii eschscholtzii* Gray. Figs. 82, 84. Map 36.

TYPE LOCALITY. California.

RANGE. From British Columbia (mainland and Vancouver Island) south to southern California, west of the Sierra and Cascade Mountain systems.

HABITAT. Found beneath logs and bark and other suitable cover, usually in moist situations, but occasionally where it is fairly dry; often

abundant in the Redwood and Douglas-fir forests and in mixed softwoods and hardwoods.

SIZE. Adults reach an extreme length of $5\frac{5}{16}$ " (135 mm.) and are thus intermediate in size between *E. sierra* and *E. croceater*. A series of 9 adults of both sexes varied in length from $3\frac{7}{32}$ " (82 mm.) to 5" (117 mm.) and averaged $3\frac{7}{8}$ " (99 mm.). The proportions of an adult male from Alder Creek, Oregon, taken June 15, 1936, are as follows: total length 5" (117 mm.), tail $2\frac{6}{16}$ " (60 mm.); head length $1\frac{10}{16}$ " (16 mm.), width $\frac{3}{8}$ " (9.5 mm.). An adult female from Portland, Oregon, Dec. 23, 1933, has the following measurements: total length $3\frac{9}{16}$ " (91 mm.), tail $1\frac{13}{32}$ " (36 mm.); head length $1\frac{1}{32}$ " (15 mm.), width $\frac{9}{16}$ " (10 mm.).

DESCRIPTION. Viewed from above, the head is roughly oval in outline, the sides behind the eyes curving gently to the lateral extensions of the gular fold and in front more abruptly to the truncated snout. The snout in side view obliquely truncate. The eyes are of moderate size and protuberant. An impressed sinuous line from the posterior angle of the eye to the lateral extension of the gular fold; a short vertical groove from this to the angle of the jaw. Gular fold well developed. Trunk well rounded and with a slight median impressed line above. There are 12 costal grooves, counting 1 each in the axilla and groin (that of the axilla scarcely developed), and the toes of the appressed limbs just meet or may overlap 3 intercostal spaces. Tail with a definite constriction at base immediately behind the vent. The tail is broadly oval in section at the base and, in the female, is widest at about the basal third, thence tapering evenly to the slightly compressed tip. In the male the tail is longer, slimmer, and only slightly swollen. In both sexes the tail is rounded above, where it is supplied with poison glands, and fairly sharp-edged below. Legs moderate in size but well developed. Toes 5-4, those of the hind feet 1-5-2-(3-4) in order of length from the shortest; toes of the fore feet 1-4-2-3. Tongue moderate in size, roughly oval in outline, and free at the sides and hind margins only, the surface finely papillose. Vomerine teeth in very long series which arise outside and behind the

inner nares at a point about opposite the anterior angle of the eye and curve forward, then inward and sharply backward, to the mid-line, where they are nearly in contact. There are 23-30 teeth in each series in the male and 26-31 in the female. The parasphenoid teeth in 2 separate elongate club-shaped patches, separated from the vomerine by about 3 times the diameter of an inner naris.

COLOR. The general ground color above varies from yellowish-brown

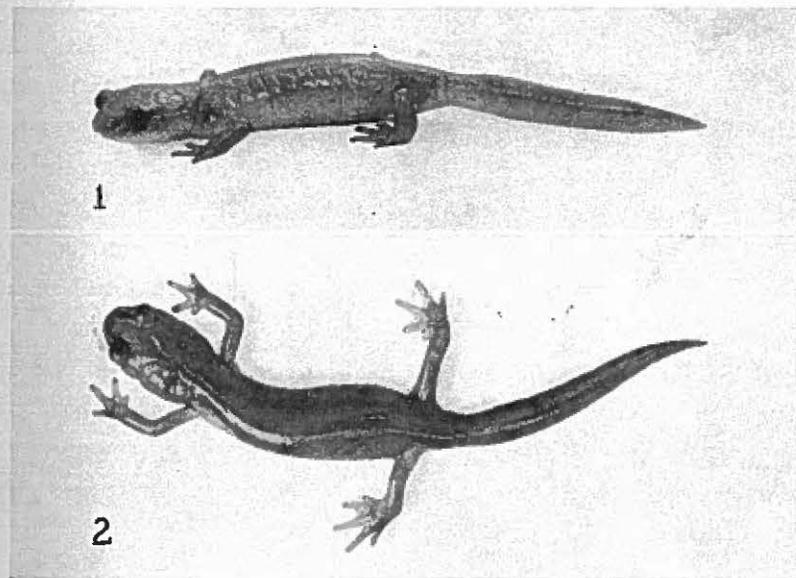


FIG. 84. *Ensatina eschscholtzii eschscholtzii* Gray. (1) Adult female, actual length $3\frac{9}{32}$ " (84 mm.); (2) Same, dorsal view. Portland, Oregon. Tip of tail regenerated.

to light reddish-brown on the head, trunk, and tail; the basal segments of the legs are yellowish above, particularly at the points of insertion. The darker color of the upper sides fades slightly to a line immediately above the legs and is in rather strong contrast to the pale lower sides. In many specimens the sides are dusted with light gray. The belly is flesh color in life, the throat and ventral surface of the tail whitish; sides of tail frequently clouded with dusky. Usually, when the dorsal color is yellowish-brown, the legs at the insertion are yellowish-orange; in the reddish-brown specimens the legs at the base above are bright

orange and there are scattered flecks of red-orange on the sides of the tail and fine reddish-orange specks on the lower sides of the trunk. In the adult male the tail is comparatively slender and comprises about 50 per cent of the total length, while in the female the tail is swollen at the basal third and comprises about 40 per cent of the length. The vent of the male is larger, longer, and more strongly protuberant, and the snout more abruptly truncated and swollen at the nasolabial region.

BREEDING. While little is known of the breeding habits, the eggs have been reported a number of times. Van Denburgh (1898, p. 140) mentions a lot found with a female at Mill Valley, Marin County, California, April 19, 1896, beneath a rotting log in the redwood forest. An adult with 34 eggs, taken Oct. 26, 1931, at Berkeley, California, is in the collection of the Museum of Vertebrate Zoology at Berkeley. These eggs are white and the size of a small pea. Eggs have also been found at Inverness, Marin County, California, June 4, 1913. This lot of 13, accompanied by 2 adults, was found in the tunnel system of the rodent *Aplodontia rufa phæa*. Individual eggs, after preservation in alcohol, measured 5.5–5.75 mm. in diameter, and, with their outer jelly coat, 5.9–7.5 mm. (Storer, 1925, p. 112). Another lot mentioned by Storer (*ibid.*) from Carlotta, Humboldt County, may belong to the subspecies *picta* recently described (see just below).

Four young from Portland, Oregon, collected Jan. 13, 1934, by Stanley G. Jewett, Jr., varied in total length from 29.5 to 45 mm. The color range is from deep brown to bluish-black above, very finely dotted with pale bluish-white points. The distal third of the tail is reddish brown and the legs above, at the insertion, bright red-orange. The belly is bluish, the lower surface of the tail and throat dull white.

PAINTED SALAMANDER. *Ensatina eschscholtzii picta* Wood. Fig. 85. Map 36.

TYPE LOCALITY. Klamath, Del Norte County, California.

RANGE. A narrow coastal area, from the vicinity of Weott, Humboldt

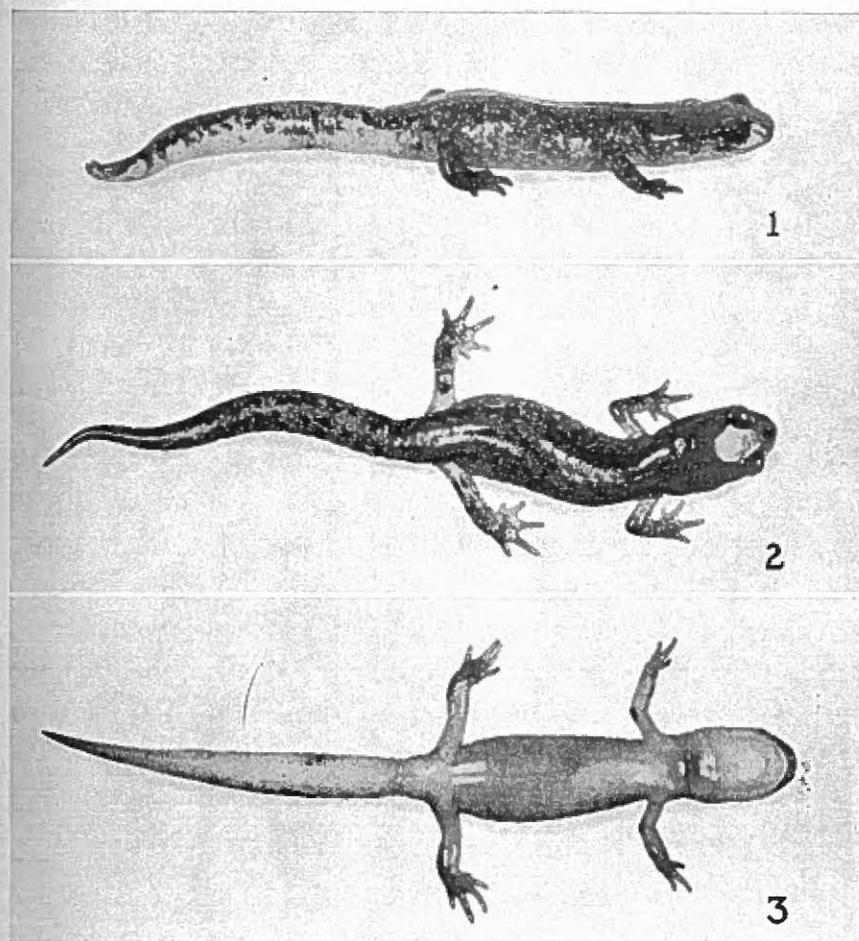


FIG. 85. *Ensatina eschscholtzii picta* Wood. (1) Adult female, actual length $3\frac{7}{16}$ " (88 mm.). (2) Same, dorsal view. (3) Same, ventral view. Del Norte County, California. [A. H. Wright, collector.]

County, California, northward through Del Norte County at least to Port Orford, Curry County, Oregon (Wood, 1940, p. 425).

HABITAT. This form has been taken in numbers in the dense redwood forests, in fir and spruce woods, and beneath debris in open areas (Wood, *ibid.*, p. 427). On June 2, 1936, we collected in the Alexander

redwood grove, about 2 miles south of Miranda, California, and found 2 specimens beneath bark on the ground. On June 6, at Carpentersville, Oregon, adults were found beneath stones on a burned-over gully side.

SIZE. Wood (1940, p. 427) gives the average and extreme measurements of 40 specimens of both sexes from Del Norte County, California, as follows: average total length $3\frac{1}{2}$ " (86.9 mm.), extremes $2\frac{1}{16}$ " (72 mm.) and $4\frac{3}{32}$ " (104 mm.). The proportions of an adult female from Carpentersville, Oregon, are: total length $2\frac{2}{32}$ " (73 mm.), tail (tip regenerated) $1\frac{1}{32}$ " (31 mm.); head length $\frac{1}{2}$ " (13 mm.), width $\frac{9}{32}$ " (7 mm.).

DESCRIPTION. This subspecies does not attain the size of the typical form and is mottled and blotched above. The head is large in proportion to the body, the sides behind the eyes nearly parallel to the lateral extensions of the gular fold, in front tapering abruptly to the short and bluntly pointed snout. The eyes are large and strongly protuberant, limited behind by a vertical fold. An impressed sinuous line from the posterior angle of the eye bends down posteriorly to meet the gular fold; a short vertical groove from this line extends to the angle of the jaw. The trunk is slightly depressed and with a slight middorsal impressed line. Costal grooves 12, counting 1 each in the axilla and groin, and $2\frac{1}{2}$ -3 intercostal folds overlapped by the toes of the appressed limbs. Tail in the female short, flattened above at base, roughly spindle-shaped, and largest at about the middle of the length; tail of male longer and slimmer; a marked constriction immediately behind the vent. Legs rather short and stout. Toes 5-4, those of the hind feet 1-5-2-(3-4) in order of length from the shortest; toes of the fore feet 1-4-2-3. Tongue of moderate size, not completely filling the floor of the mouth, broadly oval in outline, free at the sides and behind. Vomerine teeth 19-21 in long series which arise outside the outer margin of the inner nares and arch broadly toward the mid-line, where they are separated by about $\frac{1}{2}$ the diameter of a naris. Parasphenoid teeth in 2 club-shaped patches narrowly separated behind, more widely separated anteriorly, and dis-

tant from the vomerine teeth by about 3 times the long diameter of a naris.

COLOR. The general ground color of the trunk above is light reddish-brown. In many individuals, a dark line borders the upper edge of the groove running from the posterior angle of the eye to the gular fold. Extending from the back of the head to the base of the tail, a dorsolateral series of deep brown or blackish blotches; an interrupted middorsal line of small blotches, and another line on the lower sides between the fore and hind legs. The sides between the darker lines yellowish and lightly flecked. Sides and dorsum of tail strongly blotched with deep brown on a yellowish ground color. Belly and ventral surface of legs yellowish, venter of tail sometimes orange-yellow. Base of legs above yellowish, rest of legs mottled brown and yellow. Juvenile individuals often with the cheeks, tail, and basal segments of the legs above lighter, orange-red. The sides of the vent of the male somewhat swollen; the vent within lined with small papillae.

BREEDING. It is likely that the 2 adults, each found with a lot of 16 eggs at Carlotta, Humboldt County, California, on July 26, 1923, and reported by Storer (1925, p. 112), belong to this subspecies. The eggs and attendant adults were found under slabs of redwood on the ground. The eggs, in a relatively early stage of development, measured 5-5.5 mm. in diameter, and with the apparently single jelly envelope 7.6-7.8 mm. When found the eggs were nearly transparent; after preservation the yolk became opaque.

SIERRA NEVADA SALAMANDER. *Ensatina sierra* Storer. Fig. 86. Map 36.

TYPE LOCALITY. Yosemite Valley, Mariposa County, California.

RANGE. Transition zone of the Sierra Nevadas from Butte to Tulare Counties, California.

HABITAT. In and beneath logs and bark, usually in wooded areas. A specimen taken August 6, 1940, by Catherine Hemphill Brown, was found in a rotting log beside a trickling stream near Fern Spring, Yosemite Valley.

SIZE. Attains a length of $5\frac{5}{32}$ " (131 mm.). A female of this size had a tail length of $2\frac{3}{16}$ " (55 mm.) and a head length of $\frac{3}{4}$ " (19 mm.). (Dunn, 1926, p. 186.) The proportions of a small adult female from Fern Spring, Yosemite Valley, are as follows: total length $3\frac{7}{32}$ " (81 mm.) tail $1\frac{7}{16}$ " (36 mm.); head length $\frac{5}{8}$ " (16 mm.), width $1\frac{1}{32}$ " (8 mm.).

DESCRIPTION. The strongly contrasting orange-and-black markings make this one of our most brightly colored salamanders. The head is large and long in proportion to the body, and convex above in the region back of the eyes. The sides of the head are nearly parallel but are constricted abruptly at the gular fold; in front tapering rather sharply to the bluntly pointed snout. The eyes are large and prominent, the iris dark brown slightly flecked with brassy. A deeply impressed line from the posterior angle of the eye extends on the side of the head to the lateral extension of the gular fold; a short vertical groove from this passes behind the angle of the jaw. The trunk is well rounded and provided above with a slightly impressed median line. There are 12 costal grooves, counting 1 each in the axilla and groin, and the toes of the appressed limbs may meet or overlap 2-3 intercostal spaces. Tail nearly oval in section at base and with a definite constriction immediately behind the vent. It is widest at about the basal third and tapers from that point uniformly to the tip. The tail is rounded above, sharp-edged below, and comprises 35.1-40 per cent of the total length. Legs well developed, the hind noticeably larger than the fore. Toes 5-4, those of the hind feet 1-5-2-3-4 (or 4-3) in order of length from the shortest, very slightly webbed at base; toes of the fore feet, 1-4-2-3. Tongue small, thin, bluntly pointed anteriorly, and with the sides and hind margins free. Vomerine teeth in long series of 17-24 or more. The series arise outside and behind the inner nares and curve inward toward the mid-line, where they are usually separated by about the width of an inner naris. Parasphenoid teeth in 2 elongate patches which may be separated or slightly in contact anteriorly and more divergent posteriorly. They are

separated from the vomerine series by about twice the diameter of an internal naris.

COLOR. The general ground color is deep seal-brown to blackish, but is made to appear somewhat lighter by the presence of many small white

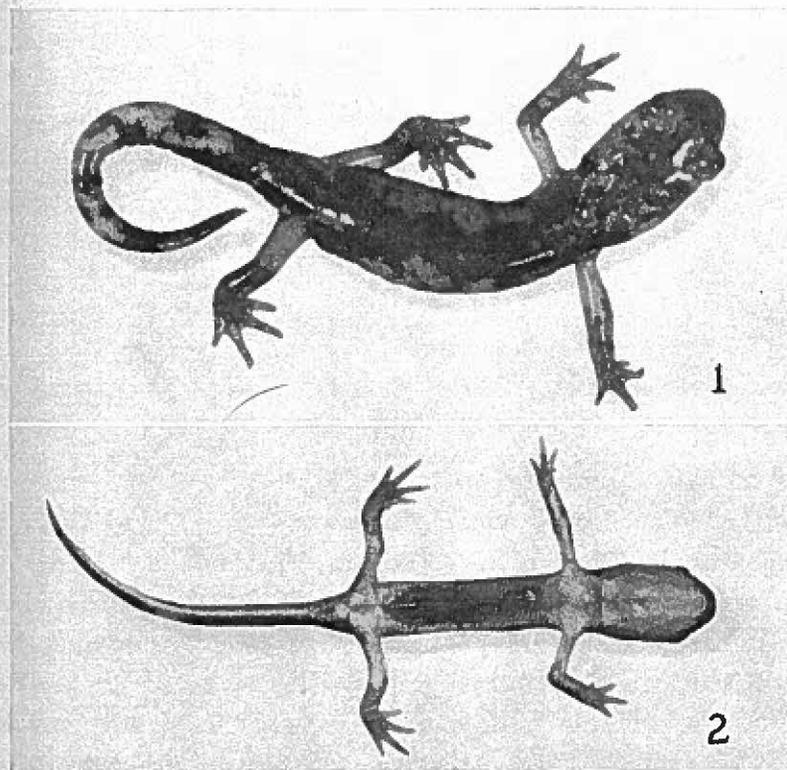


FIG. 86. *Ensatina sierra* Storer. (1) Adult male, actual length $2\frac{1}{16}$ " (76 mm.). (2) Same, ventral view. Fern Spring, Yosemite Valley, California. [Mrs. Stuart Brown, collector.]

pigment flecks scattered generally over the upper surfaces. The bright orange and orange-yellow blotches are irregular in size and shape and on the trunk confined largely to the sides. On the head they are largest on the sides back of the eyes, but are continued across the back of the head and between the eyes, leaving a median dorsal spot relatively free.

The snout is generally dark, relieved by a few white flecks. On the tail, the orange blotches tend to be brighter than elsewhere; they are greater in area than the dark brown interspaces and cross the dorsal surface. The basal joints of the legs are quite uniformly orange-yellow, the rest of the legs blotched with gray and orange; the feet mostly pale gray. The general color of the throat and belly is pale slate, the lower surface of the tail very light gray.

BREEDING. Nothing has been reported on the breeding habits of this species. Specimens only 36 mm. long have been found in June, and those having lengths of 39 and 42 mm. respectively have been taken in February and March (Storer, 1925, p. 107).

GENUS HEMIDACTYLIUM

EASTERN FOUR-TOED SALAMANDER. *Hemidactylium scutatum* (Schlegel).

Figs. 49a, 87. Map 37.

TYPE LOCALITY. Nashville, Tennessee.

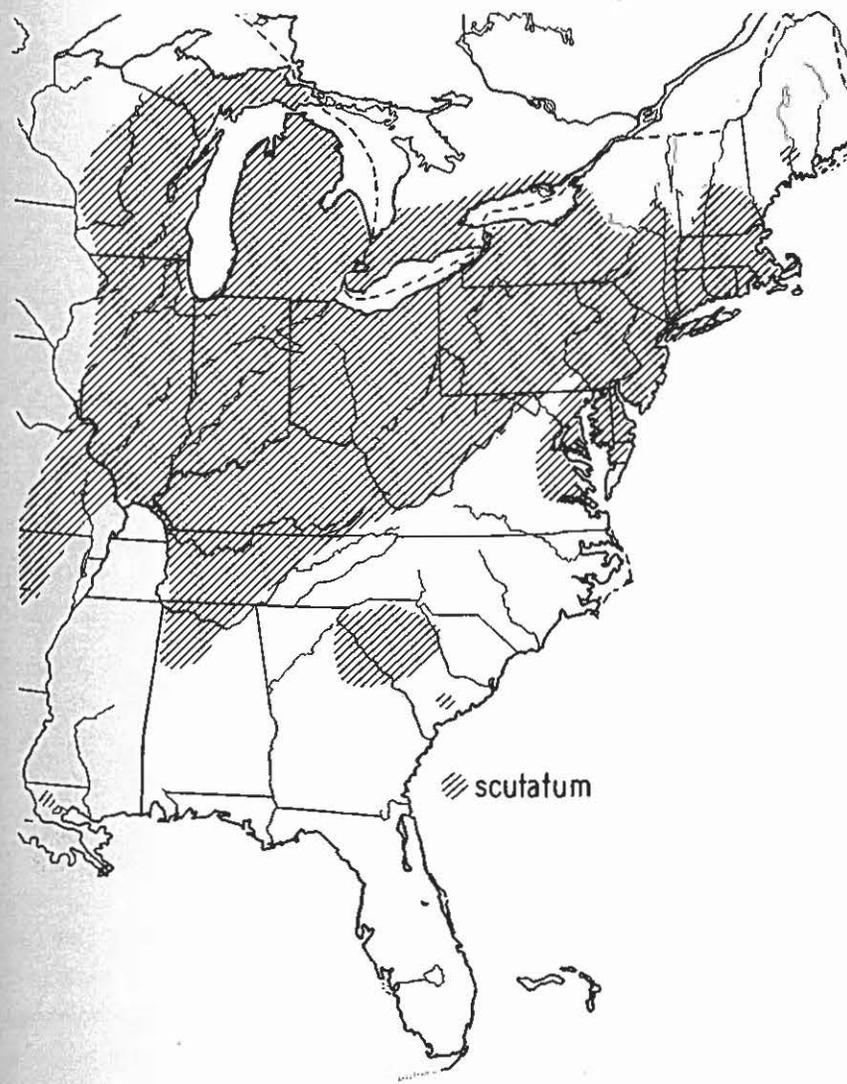
RANGE. Southern Ontario and Maine westward to Wisconsin, south to Georgia and Alabama; also Arkansas, Missouri, and Illinois.

HABITAT. The adults are usually found in terrestrial situations, inhabiting wooded or more or less open areas adjacent to sphagnum bogs, swamps, quiet pools, and larch meadows.

SIZE. One of the smallest salamanders, adult males averaging only $2\frac{9}{16}$ " (65 mm.) in length and varying from 2 to 3" (50-76 mm.). The females are a little larger and average nearly 3" (75 mm.). They vary from $2\frac{7}{8}$ to $3\frac{1}{2}$ " (62-89 mm.).

DESCRIPTION. The body is nearly cylindrical, the trunk short, and provided with an impressed median line. The tail is broadly oval in section at the base, swollen at its mid-length, and only slightly compressed distally. At the base of the tail there is a definite constriction marking the point of detachment in autotomy. The head is somewhat flattened, the snout broadly rounded in the female and squarely truncate in the male. There are 13-14 costal grooves and the gular fold is well formed.

The legs are slender but relatively strong, toes 4-4, inner and outer rudimentary. Vomerine teeth in the male are in single backward-curving lines, usually separated from the parasphenoid patches. In the female the vomerine series may consist of 2 or more irregular rows. The tongue



MAP 37.—Distribution of *Hemidactylium scutatum*. (Also reported from Durham County, North Carolina.)

is small, narrow, and bluntly rounded behind and in front. The head and trunk above reddish-brown, fading slightly on the upper sides and

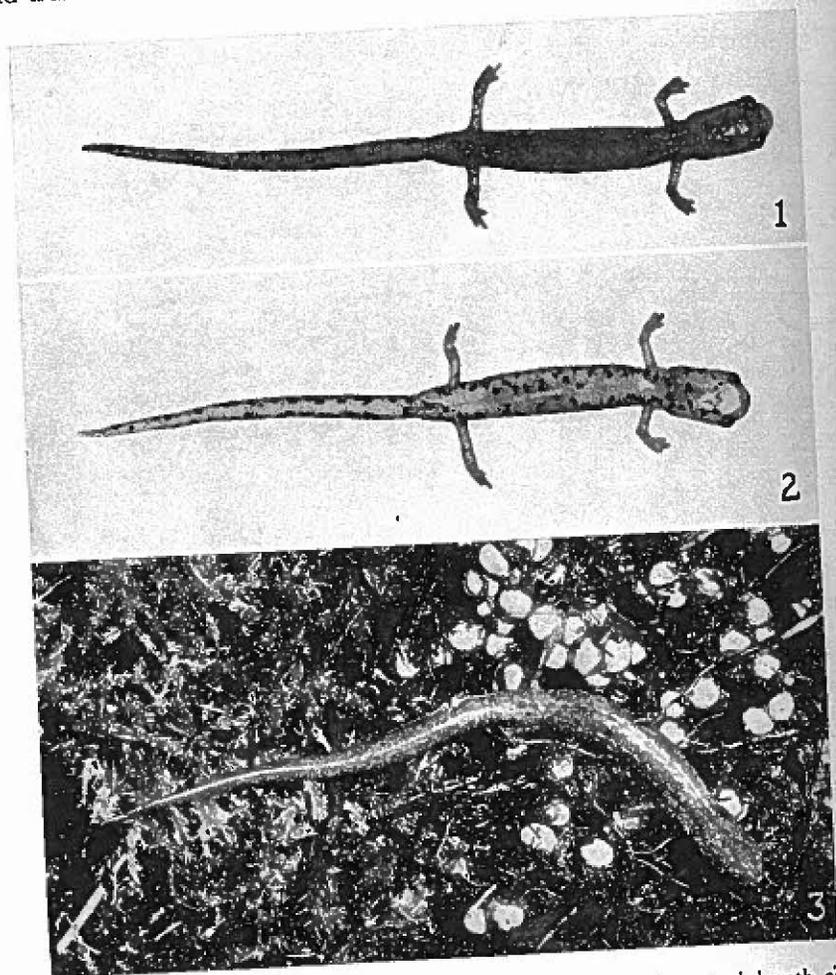


FIG. 87. *Hemidactylum scutatatum* (Schlegel). (1) Adult male, actual length $2\frac{1}{16}$ " (62 mm.). (2) Same, ventral view. Mendon Ponds, Monroe County, New York. (3) Adult female with eggs. New Salem, New York, May 18, 1923.

becoming distinctly grayish on the lower sides between the costal grooves. The upper surface of the legs and tail has the ground color dull reddish-orange blotched with brown. The snout is bronzy and on each side above the shoulders there is a small, elongate, light yellowish-

red patch. The venter is bluish-white, with small, irregular, inky-black flecks scattered over the surface. The mature males differ from the females in their smaller average size, more slender form, relatively longer tail, more squarely truncate snout, and in the disposition of the vomerine teeth. The 3 or 4 teeth on the premaxillary of the male are enlarged and sometimes perforate the lip.

BREEDING. There is an extended mating season through late summer and fall, and fertilization is accomplished by means of spermatophores. In the early spring, the females leave their winter quarters and migrate to the breeding grounds. The eggs are deposited in close proximity to water and usually in little cavities in sphagnum moss or among the roots of grass, rarely in rotting wood. The approximately 30 eggs are deposited singly and are not aggregated by a common envelope, but cling to one another and to the nest materials by the adhesive outer envelope. When depositing her eggs the female turns upon her back. Usually the female remains with the eggs until they hatch, and often many females will deposit their eggs in such close proximity to one another that it is impossible to determine the limits of individual masses. Under these circumstances only a few females remain in attendance. The individual egg has a diameter of 2.5-3 mm. and is surrounded by two envelopes, in addition to the vitelline membrane, which give a total diameter of about 5.3 mm. The incubation period may be limited to 38 days or extended to 60.

LARVAE. Larvae at hatching average about $\frac{1}{2}$ " (12.4 mm.). The head is broad, the snout bluntly pointed. The trunk and tail are strongly compressed and wedge-shaped. The fore legs have 4 toes sometimes indicated, the hind legs short and directed backward. The gills are slender, tinged with orange at the base, and pigmented with black. The tail is keeled and continuous with the keel of the back, a condition unique among the larvae of the plethodontid salamanders. The head of the larva is tinged with orange, green, and yellow, and marked with dark brown or black. On the side of the head, a short, wide, dark bar extends from the eye to the gills. Along the mid-line of the trunk there

is a light band with irregular edges bordered each side by dark worm-like markings. There is an aquatic larval stage of about 6 weeks and the transforming young attain a length of about $\frac{3}{4}$ -1" (18-25 mm.). Sexual maturity is probably attained at an age of about 2½ years.

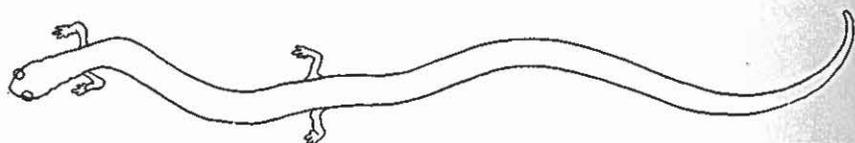


FIG. 88. Outline of *Batrachoseps attenuatus* to show the elongate form of the body and the four toes on both fore and hind feet. [H.P.C. del.]

GENUS BATRACHOSEPS

KEY TO THE SPECIES AND SUBSPECIES OF BATRACHOSEPS

1. Belly with at least some separate black flecks on a lighter ground color 2
 - Belly with a fine network of black, enclosing small, round, light spots 4
2. Dark above, no dorsal band; hind legs when appressed to the sides overlapping $5\frac{1}{2}$ - $6\frac{1}{2}$ intercostal folds; vomerine teeth usually in a single series of 6-10, occasionally in irregular patches; parasphenoid teeth usually in 2 elongate patches narrowly separated, occasionally in a single broad patch as in *major*; length to $5\frac{1}{10}$ " (129 mm.). San Miguel, Santa Rosa, Santa Cruz, and Santa Barbara Islands off the west coast of California *attenuatus pacificus* p. 323
 - With at least a faint dorsal band 3
3. Venter with separate black flecks only; hind legs when appressed to the sides overlapping $4-4\frac{1}{2}$ intercostal folds; vomerine teeth in short patches of 1-3 rows; parasphenoid teeth in a single broad patch broadly rounded behind, pointed anteriorly, and narrowly separated from the vomerine; length to $6\frac{3}{8}$ " (162 mm.). Los Angeles, Riverside, Orange, and San Bernardino Counties, California *attenuatus major* p. 320
 - Venter with black flecks confined to the central area, reticulated along sides; hind legs when appressed to the sides overlapping 4 intercostal folds; vomerine teeth in short patches, occasionally in rows of 6 or 7; parasphenoid teeth in a broad patch with a median groove incompletely separating the two sides or in 2 narrowly separated elongate patches; length to $5\frac{7}{32}$ " (133 mm.). Santa Catalina Island, California *attenuatus catalinae* p. 315
4. With a median dorsal stripe lighter than adjacent sides 5

- Without a conspicuous dorsal stripe; back scarcely lighter than sides . . . 6
5. Dorsal light stripe well developed; venter fairly dark; head narrow; legs small, the hind when appressed to the sides overlapping $3-3\frac{1}{2}$ intercostal folds; vomerine teeth in short patches of 2 or 3 rows; parasphenoid teeth in a single broad patch, broadly rounded behind, slightly narrowed and notched in front (southern part of range) or, patch more elongate, narrowed anteriorly and with a groove at mid-line extending $\frac{1}{2}$ the length (northern); length to $5\frac{3}{4}$ " (136 mm.). Santa Cruz Island and Los Angeles County, California, northward to southwestern Oregon *attenuatus attenuatus* p. 311
 6. Dark brown above, sometimes with a faint indication of a lighter dorsal band; sides dark, venter a little lighter; lower sides and margins of belly with many small grayish flecks; costal grooves 18-20; vomerine teeth in 2 imperfect rows of 5-8 or in short patches; parasphenoid teeth in 2 long club-shaped patches, united posteriorly, separated in front by a V-shaped groove, rarely in a single broad patch; length to 5" (128 mm.). Southwestern California, Lower California, Los Coronados Island. Also recorded from Nevada de Colima, Colima, Mexico *attenuatus leucopus* p. 317
 - Dark brown above, slightly lighter below; no light gray flecks evident on lower sides and belly; costal grooves 21; vomerine teeth in short double series; length of type, $6\frac{25}{32}$ " (172 mm.). Alaska *caudatus* p. 325

WORM-SALAMANDER. *Batrachoseps attenuatus attenuatus* (Eschscholtz).

Figs. 88-89. Map 38.

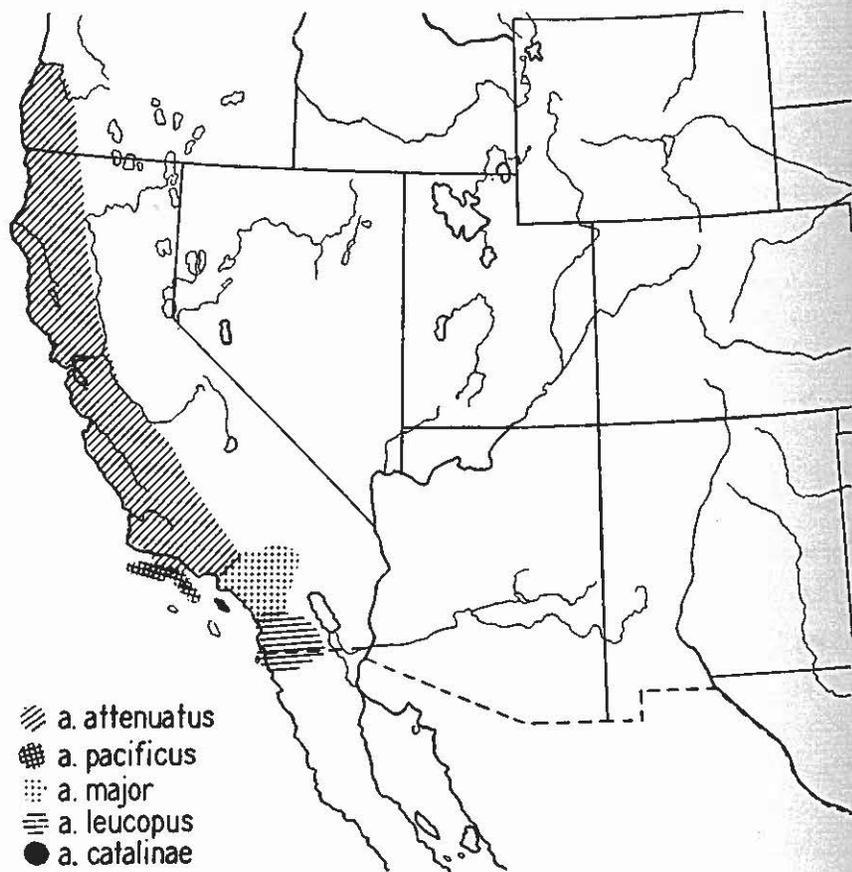
TYPE LOCALITY. Vicinity of the Bay of San Francisco, California.

RANGE. Southwestern Oregon, California to Los Angeles County, and lower western slopes of the Sierra Nevada (Stejneger and Barbour, 1939, p. 18). Also recorded from Santa Cruz Island (Campbell, 1931, p. 132).

HABITAT. Under logs, bark, boards, and stones on the ground, usually in moist situations, and in rotting logs, old stumps, and leaf mold. Burrows deeply during dry seasons.

SIZE. The average length of 15 adults of both sexes from various California localities is $3\frac{15}{32}$ " (89 mm.), the extremes $2\frac{7}{8}$ " (73 mm.) and $4\frac{7}{16}$ " (114 mm.). Burke (1939, p. 211) indicates that an extreme length of $5\frac{3}{4}$ " (136 mm.) may be attained. The proportions of a male from Berkeley, California, are as follows: total length 4" (102 mm.), tail

$2\frac{5}{32}$ " (55 mm.); head length $1\frac{1}{32}$ " (9 mm.), width $\frac{7}{32}$ " (4.5 mm.). A female from the same locality measures: total length $3\frac{11}{16}$ " (94 mm.), tail $1\frac{31}{32}$ " (50 mm.); head length $\frac{5}{16}$ " (8 mm.), width $\frac{3}{32}$ " (4 mm.).



MAP 38.—Distribution of the subspecies of *Batrachoseps attenuatus*.

DESCRIPTION. The light dorsal band, narrow head, and dark venter characterize this salamander. The head is widest immediately back of the eyes, the sides behind tapering gently to the lateral extensions of the gular fold and in front abruptly to the short, bluntly rounded snout. The eyes are of moderate size and limited behind by an oblique fold

and groove. An impressed sinuous line from the posterior angle of the eye to the lateral extension of the gular fold; a short vertical groove from this line to a point behind the angle of the jaw and another about midway between the angle of the jaw and gular fold. Nasolabial grooves poorly developed. The trunk long, slender, and subcylindrical, slightly flattened below, and with an impressed median line above. The costal grooves usually 20, counting 1 each in the axilla and groin, but many specimens have only 19, occasionally 18 or 21, and there are $10-12\frac{1}{2}$ intercostal spaces between the toes of the appressed limbs. The tail is nearly circular in section throughout its length, tapering only slightly to about the distal fourth, then more abruptly to the pointed tip. The tail is completely encircled by grooves that give a decidedly worm-like appearance. Legs very small and slender, the hind overlapping only $3-3\frac{1}{2}$ intercostal folds when appressed to the sides. Toes 4-4, very short and ball-tipped, the innermost rudimentary, 1-4-2-3 in order of length from the shortest. Tongue small, roughly oval in outline, provided with a central pedicel and freely protrusible. Vomerine teeth in 2 short patches consisting of 2-3 rows, the patches usually separated at the midline by about the width of an inner naris and widely diverging anteriorly. The patches lie behind and wholly between the inner nares and are widely separated from the parasphenoids. Parasphenoid teeth may form a single large patch, broad behind and slightly narrowed anteriorly, or there may be 2 patches narrowly separated. Some adult males with enlarged premaxillary teeth and lower jaw narrowed anteriorly.

COLOR. The broad dorsal light band varies from light tan to brownish-red. The band may be almost uniform in color throughout, marked with a definite herringbone pattern, darker on the trunk and with a median dark line on the tail, or the median area of the band may be dark, the lateral margins light. The dorsal band is usually limited on either side by a narrow line somewhat darker, black or brown, and the sides below the line may appear bronze, chocolate-brown, or have a pepper-and-salt effect. The ventral pattern consists of a network of dark lines enclosing nearly circular light spots, so that the general color is dark, but some

specimens have a few irregular lighter pigment flecks on sides and belly. The lower surface of the tail is sometimes greenish-yellow.

BREEDING. The egg-laying of this species was observed by Maslin (1939,

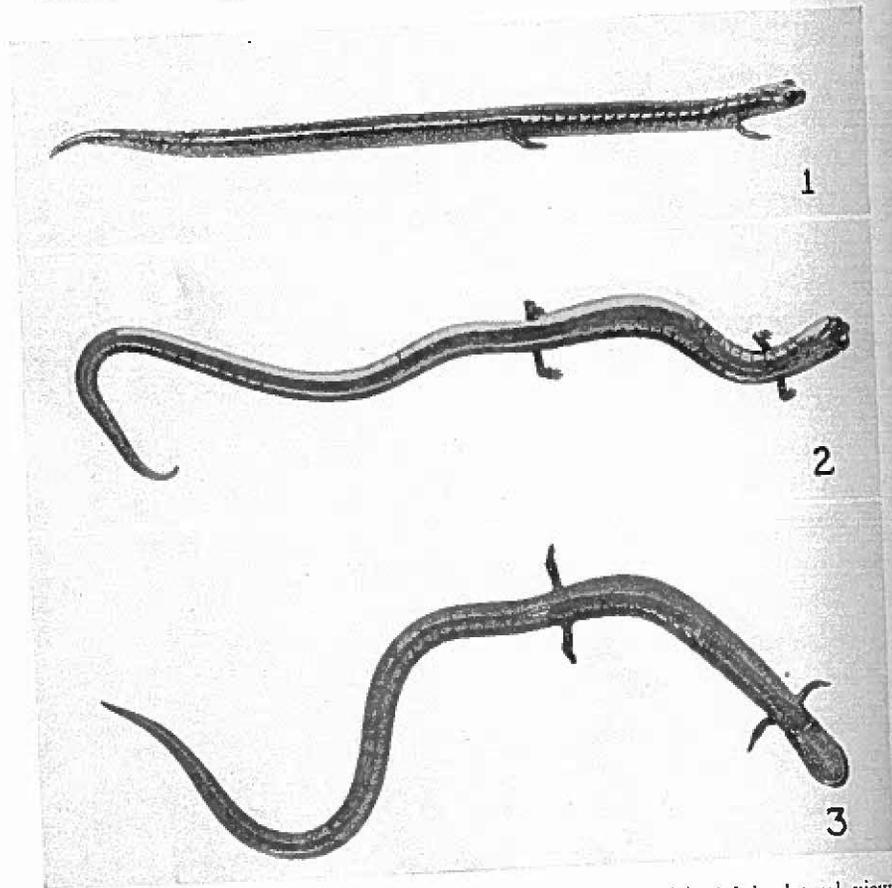


FIG. 89. *Batrachoseps attenuatus attenuatus* (Eschscholtz). (1) Adult, lateral view. Muir Woods, Marin County, California. (2) Adult female, actual length $4\frac{1}{2}$ " (113 mm.). (3) Same, ventral view. Near Fort Ross, California.

p. 209) on Nov. 5, 1938. This is an early record for the vicinity of Berkeley, California, and the laying may have been initiated by the start of the rainy season. Other egg masses have been found in the field in January, near Palo Alto, California (Burke, 1911, p. 414), and at Snelling, Merced County, California (Grinnell and Storer, 1924, p. 654);

in March at Berkeley and Palo Alto (Storer, 1925, p. 24). Individual females deposit 12-15 eggs, but several may select the same retreat, beneath logs, rocks, or boards, or in pockets in the soil, in moist situations, and the total complements number as many as 74 (Burke, 1939, p. 211). Individual eggs when freshly deposited have a diameter of 4 mm. and are without pigment. They are surrounded by 3 envelopes, the inner of viscous jelly, the middle of semi-rigid jelly, and the outer thin and tough but not sticky. The eggs are attached to one another, sometimes in a bead-like string, and to surrounding objects by a gelatinous peduncle which may be 12 mm. long. The diameter of the outer envelope is 6 mm. Development under natural conditions is relatively slow and the time of hatching variable, but in the field probably occurs in the spring. (Burke, *ibid.*, pp. 209, 211.) A recently hatched young examined by Storer (1925, p. 96) measured as follows: total length 19 mm., tail 6 mm.; head width 2 mm. "The general coloration was black, with a slight brownish tinge; on the back were four parallel lines of spots silvery white and reddish gold in color; the ventral surface of the body was marked generally with scattered patches of silvery white."

CATALINA ISLAND SALAMANDER. *Batrachoseps attenuatus catalinae* Dunn. Fig. 90. Map 38.

TYPE LOCALITY. Santa Catalina Island, California.

RANGE. Santa Catalina Island, California.

HABITAT. During the rainy season not uncommon beneath surface materials and often discovered in numbers during the excavation of ditches, cellars, and sewers. During the dry season it burrows deeply.

SIZE. The average length of 9 adults of both sexes is $4\frac{3}{16}$ " (105.7 mm.), the extremes $3\frac{3}{32}$ " (79 mm.) and $5\frac{7}{32}$ " (133 mm.). The proportions of a male, U. S. N. Mus. No. 89670, are as follows: total length $4\frac{17}{32}$ " (116 mm.), tail $2\frac{3}{4}$ " (70 mm.); head length $1\frac{1}{32}$ " (9 mm.), width $\frac{7}{32}$ " (6 mm.). An adult female, U. S. N. Mus. No. 89674, has the following measurements: total length $5\frac{7}{32}$ " (133 mm.), tail $3\frac{1}{16}$ " (78 mm.); head length $\frac{3}{8}$ " (10 mm.), width $\frac{7}{32}$ " (6 mm.).

DESCRIPTION. For living examples of this salamander I am indebted to Mr. Joseph R. Slevin, who collected a fine series at Avalon, Santa Catalina Island, in April 1941. The head is narrow, the sides behind the eyes converging slightly to the lateral extensions of the gular fold and

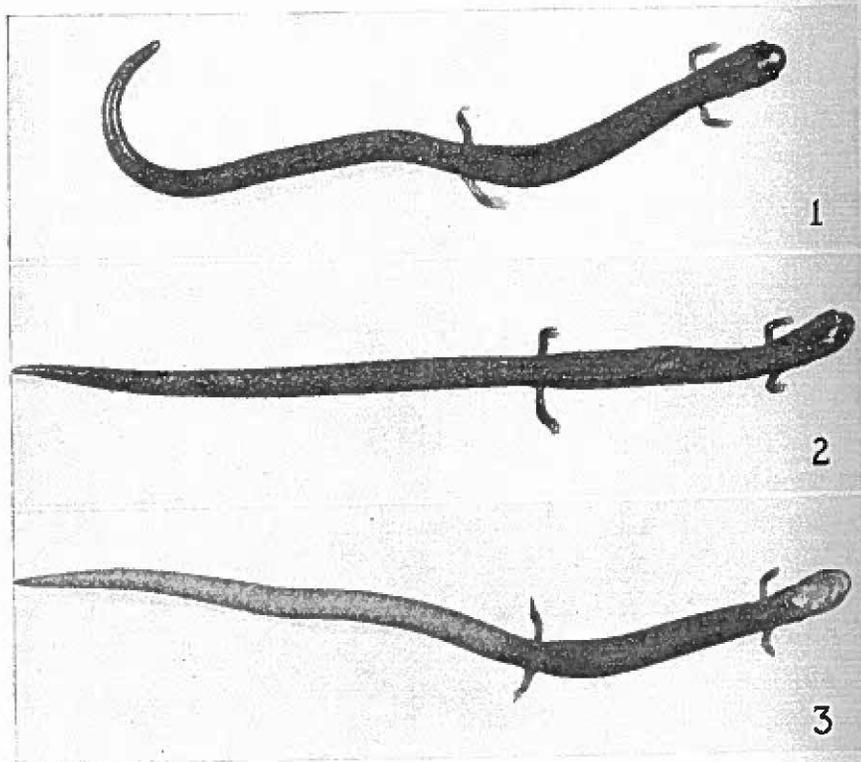


FIG. 90. *Batrachoseps attenuatus catalinae* Dunn. (1) Adult female, actual length $3\frac{1}{2}$ " (89 mm.). Santa Catalina Island, California. (2) Adult female, another individual; dorsal view. (3) Same, ventral view. [J. R. Slevin, collector.]

in front abruptly to the bluntly rounded snout. The eyes are large and strongly protuberant, the long diameter a little greater than the length of the snout; the skin above the eyes black with gold flecks; the iris flecked with brassy. An impressed line from the posterior angle of the eye to the lateral extension of the gular fold. The trunk is subquadrate in section and with a slightly impressed median line which forks at

the back of the head and sends a branch to each eye. Costal grooves 20-21; and 10-13 costal folds between the toes of the appressed limbs. The tail is long, slender, and worm-like, and comprises from 53.2 per cent of the total length in the smaller individuals to 60.34 per cent in the large adults. The legs are slender and weak; toes 4-4, 1-4-2-3 in order of length from the shortest, the 1st rudimentary and partly fused to the 2nd. Tongue elongate oval, thin at margin, free at the sides and behind. Vomerine teeth in short irregular patches, or, rarely, in fairly regular rows of 6 or 7, which lie between the inner nares, narrowly separated at the mid-line, and about 3 times the diameter of a naris from the parasphenoids; the latter in 2 long, slender, club-shaped patches which may be narrowly separated or contiguous anteriorly.

COLOR. This salamander has a broad dorsal band which is scarcely lighter than the adjacent sides. The band is a dull bronze, darker in some individuals than in others, and extends from the snout the length of the trunk well onto the tail. The upper sides next to the dorsal band are brown, fading to grayish on the lower sides. The throat is tan or light gray, with a loose network of small black chromatophores and scattered white flecks. In most specimens, dark pigment of the belly and ventral surface of the tail forms a reticulated pattern over the purplish-gray ground color. In others the dark pigment is mostly in separate flecks along the central region of the belly and reticulated along the sides. The dorsal surface of the legs is colored like the back, the feet and toes grayish.

BREEDING. Nothing has been written on the breeding habits of this island form, and the eggs and recently hatched young have not been described.

SOUTHERN SLENDER SALAMANDER. *Batrachoseps attenuatus leucopus* Dunn. Fig. 91. Map 38.

TYPE LOCALITY. North Island, Los Coronados Islands, Baja California, Mexico.

RANGE. Los Coronados Islands; Baja California; San Diego and Imperial Counties, California.

HABITAT. Klauber (1927, p. 1) remarks concerning this species in San Diego County: "This salamander seems to be rather common in moist locations, especially shaded north slopes, throughout the western part of the County. It is frequently found in San Diego (city) gardens."

SIZE. The average length of 14 specimens from San Diego County, California, is $3\frac{1}{2}$ " (87 mm.), the extremes $2\frac{19}{32}$ " (66 mm.) and $4\frac{3}{32}$ " (127 mm.). The proportions of an adult female from San Diego, California, are as follows: total length $4\frac{15}{32}$ " (114 mm.), tail $2\frac{1}{16}$ " (68 mm.); head length $\frac{5}{16}$ " (8 mm.), width $\frac{7}{32}$ " (4.5 mm.). An adult male from the same locality has the following measurements: total length $3\frac{7}{32}$ " (82 mm.), tail 2" (51 mm.); head length $\frac{3}{8}$ " (7 mm.), width $\frac{5}{32}$ " (4 mm.).

DESCRIPTION. The head is broadly oval in outline, widest at the angle of the jaws, the sides behind this point gently rounding to the lateral extension of the gular fold, the snout short and broadly rounded. The eyes large, the long diameter about equal the length of the snout, limited behind by an oblique fold; the iris flecked above the pupil with gold. A sinuous groove from the posterior angle of the eye to the lateral extension of the gular fold; a vertical groove from this passing behind the angle of the jaw. Trunk rounded above, with an impressed median line. Costal grooves usually 19, counting 1 each in the axilla and groin, occasionally 18 or 20, and 8-11 intercostal folds between the toes of the appressed limbs. Tail worm-like; long, slender, tapering, and encircled by grooves which give it a segmented appearance; in length comprising 50-62.2 per cent of the total length, the higher figures associated with males and larger individuals. Legs very small and slender. Toes 4-4, short, bluntly rounded at tip, the innermost rudimentary; those of the hind feet, 1-(4-2)-3 in order of length from the shortest; toes of the fore feet 1-4-2-3. Tongue broad behind, bluntly pointed in front, free at the sides and behind. Vomerine teeth in short irregular patches or in series consisting of 2 imperfect rows of 5-8 teeth which

arise within or behind the inner margin of the inner naris and slant obliquely inward and backward toward the mid-line, where they may be in contact or narrowly separated. Parasphenoid teeth variable, in some in a single patch broad behind and narrowed anteriorly, in others in 2 imperfectly separated patches; in some females the patches in contact anteriorly, divergent posteriorly.

COLOR. The color is quite variable, but in general the sides are dark,

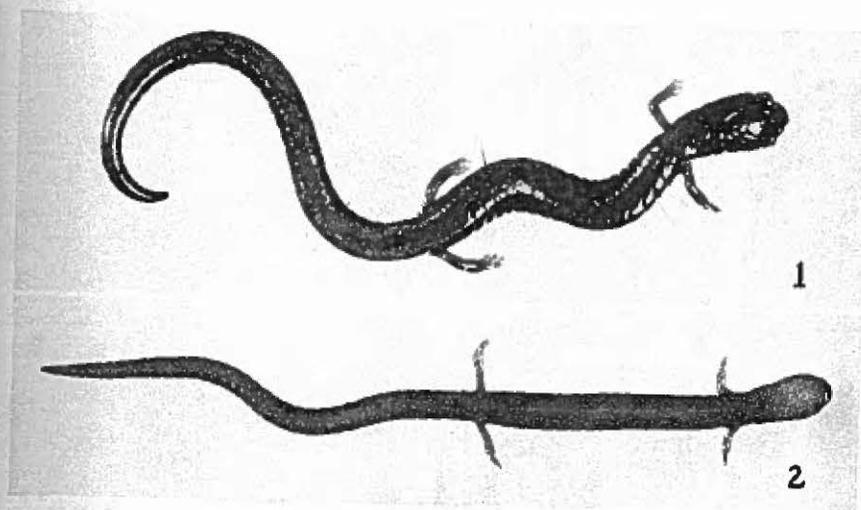


FIG. 91. *Batrachoseps attenuatus leucopus* Dunn. (1) Adult female, actual length $3\frac{1}{16}$ " (78 mm.). (2) Same, ventral view. San Diego, California. [L. M. Klauber, collector.]

the dorsal surfaces somewhat lighter. In the majority of specimens I have examined, there is a dorsal band which arises on the head and continues the length of the trunk and tail. The dorsal band may be brown or dark gray, scarcely lighter than the upper sides, or the head and trunk deep red strongly suffused with dusky, the tail much brighter, almost orange-red. Occasional individuals will have the dorsal band coppery-red throughout its length from the back of the head to the tip of the tail; in others the band may be dark on the trunk, coppery-red on the tail, and with patches of red on the snout, above the eyes, on the shoulders, and in scattered flecks along the sides of the trunk. The

ground color of the upper sides is deep brown, with minute spots of lighter brown and many flecks or lines of white. The legs above are generally colored like the sides and with a patch of red at the base. The belly has a finely reticulated black pattern over a lavender background, and along the sides many small white pigment flecks. The ventral surface of the legs, throat, and tail may be grayish or the venter of the tail yellowish.

BREEDING. Nothing is known of the breeding habits of this species, and the eggs have not been described. According to Klauber (1934, p. 5) it aestivates during the long, rainless summer.

GARDEN SALAMANDER. CAMP'S SALAMANDER. *Batrachoseps attenuatus major* Camp. Fig. 92. Map 38.

TYPE LOCALITY. Sierra Madre, Los Angeles County, California.

RANGE. Los Angeles, Riverside, Orange, and San Bernardino Counties in southwestern California.

HABITAT. Found beneath logs, boards, and rocks, or buried in loose gravel; occasionally in cellars. In May 1936 we collected a fine series from beneath the boards covering a cesspool in a yard at Claremont, California.

SIZE. A series of 6 sexually mature individuals measured by Camp (1915, p. 330) varied in length from $3\frac{1}{4}$ " (82.7 mm.) to $6\frac{3}{8}$ " (162 mm.) and averaged $4\frac{5}{8}$ " (117 mm.). The proportions of a male from Claremont, California, are as follows: total length $4\frac{13}{32}$ " (111 mm.), tail $2\frac{1}{2}$ " (63 mm.); head length $1\frac{3}{32}$ " (9.5 mm.). A female from Sierra Madre, noted by Camp (*ibid.*) measured: total length $4\frac{9}{16}$ " (115.5 mm.), tail $2\frac{19}{32}$ " (66 mm.); head width $\frac{7}{32}$ " (5.9 mm.).

DESCRIPTION. The large size, light venter, and relatively wide head distinguish this species from *Batrachoseps a. attenuatus*, with which it is sometimes associated. The head is widest at the eyes, the width comprising as much as 63.1 per cent of the head length measured from the tip of the snout to the lateral extension of the gular fold. Behind the eyes, the sides of the head usually taper slightly to the gular fold, and

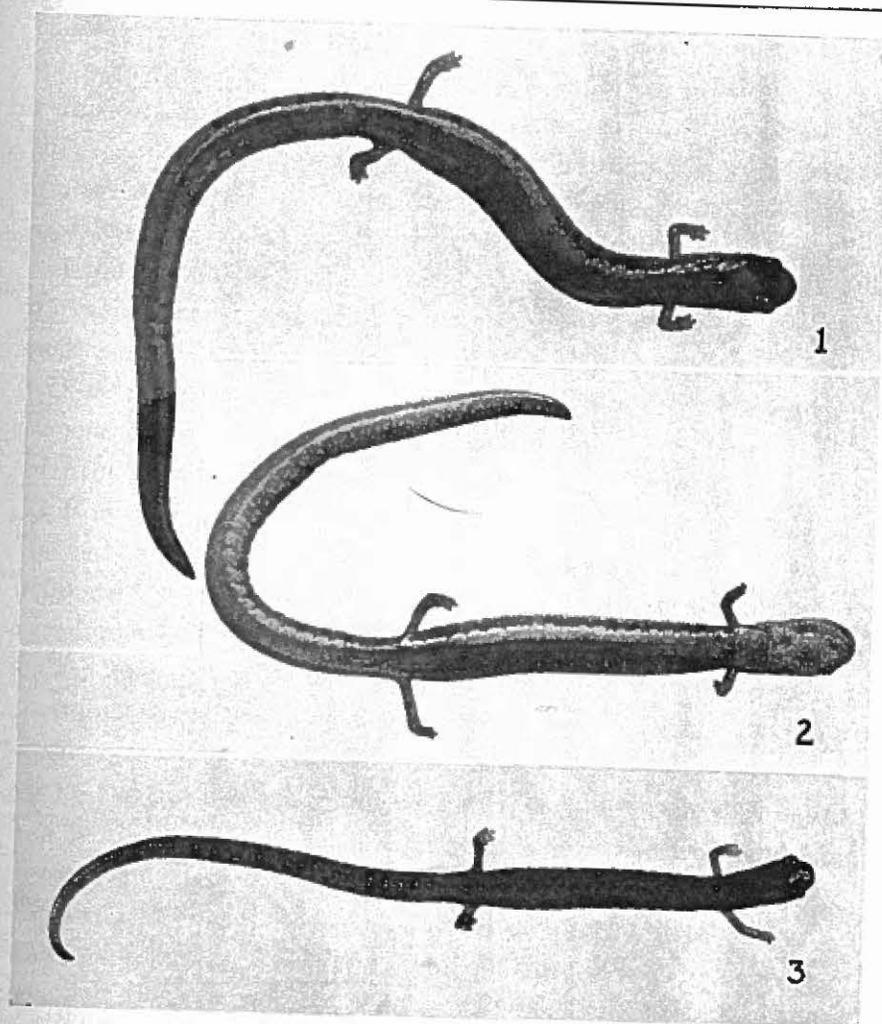


FIG. 92. *Batrachoseps attenuatus major* Camp. (1) Adult male, actual length $4\frac{13}{32}$ " (113 mm.). (2) Same, ventral view. Claremont, California. (3) Another individual. Altadena, California.

in front abruptly to the short and bluntly rounded snout. The eyes large and strongly protuberant, limited behind by an oblique fold and groove; the iris brassy in narrow lines above the pupil. A poorly developed impressed line from the posterior angle of the eye to the lateral extension of the gular fold; and a short vertical groove from this line to behind the

angle of the jaw. Nasolabial grooves scarcely evident. Trunk subcylindrical, slightly flattened below. There are usually 19 costal grooves, counting 1 each in the axilla and groin, but the number may vary from 18 to 20; 9-10 intercostal folds between the toes of the appressed limbs. Tail long, nearly circular in section throughout its length, and tapering to a slender tip. The tail length increases with size and may comprise 52-57 per cent of the total. Tail completely encircled by grooves. Legs short but not so slender as in *Batrachoseps a. attenuatus*; when appressed to the sides each overlapping 4-4½ intercostal folds. Toes 4-4, short, ball-tipped beneath, the innermost small but more nearly normal than in *B. a. attenuatus*; 1-4-2-3 in order of length from the shortest. Tongue moderate in size, roughly oval in outline, thin at the margins, and with a central pedicel; strongly protrusible. Vomerine teeth small, in short patches of 1-3 rows, narrowly separated at the mid-line and lying wholly between and slightly behind the inner nares. Parasphenoid teeth often forming a single patch, broad and rounded behind, slender and tapering anteriorly, or in 2 patches narrowly separated behind, united anteriorly; separated from the vomerine teeth by about 3 times the diameter of an inner naris. Premaxillary teeth of males not strikingly enlarged in the series examined, but point of lower jaw of the male somewhat narrower than in the female.

COLOR. Above somewhat variable, ranging from light grayish-brown to brownish-red; the dorsal surface of the tail often with brick-red spots overlaid by a stippling of light gray; the dorsal surface of the head often grayer than the adjacent trunk. Upper sides of trunk definitely brownish and sharply marked off from lower sides, which are bluish-gray. Sides of tail lighter than sides of trunk, silvery-gray with fleshy tinges. Legs brownish above, grayish on the sides. The throat is flesh color, the belly light bluish-gray, the lower surface of the tail flesh or dull yellowish-white. In some individuals there is a broad dorsal band extending from the snout to the tip of the tail, but it is never developed to the extent found in *Batrachoseps a. attenuatus*. The detailed pattern of the ventral surfaces consists of separated, small, black

chromatophores distributed uniformly over the light ground color, and a few scattered white pigment flecks. In some young individuals the entire dorsal surface of the trunk and tail and the snout in front of the eyes may be tinged with brick-red, which is in strong contrast to the brownish sides. In others, the upper surface of the tail alone may be bright red in irregular blotches. In preservatives, the general color above fades to pinkish-brown, the ventral surfaces dull yellow, resembling the colors of an earthworm.

BREEDING. Nothing is known of the breeding habits of this species, and the eggs have not been described.

PACIFIC WORM-SALAMANDER. *Batrachoseps attenuatus pacificus* (Cope).

Fig. 93. Map 38.

TYPE LOCALITY. Recorded from Santa Barbara, on the coast of Southern California, but probably from Santa Barbara Island.

RANGE. San Miguel, Santa Rosa, Santa Cruz, and Santa Barbara Islands off the west coast of California.

HABITAT. Usually found under sticks, stones, or lumps of earth in damp places; also found under loose bark of fallen trees (Slevin, 1928, p. 47).

SIZE. The average length of 13 adults of both sexes from Santa Cruz and San Miguel Islands, California, is 3²⁵/₃₂" (96.5 mm.), the extremes 2¹³/₁₆" (72 mm.) and 5¹/₁₆" (129 mm.). The proportions of the largest female (from San Miguel) are as follows: total length 5¹/₁₆" (129 mm.), tail 2³/₄" (70 mm.); head length 1³/₃₂" (11 mm.), width ⁷/₃₂ (6 mm.). An adult male from Santa Cruz has the following measurements: total length 3¹/₃₂" (77 mm.), tail 1¹⁹/₃₂" (41 mm.); head length ³/₈" (10 mm.), width ³/₁₆" (5 mm.).

DESCRIPTION. The head is widest immediately behind the eyes, tapering slightly to the lateral extensions of the gular fold, in front more abruptly to the truncated and broadly rounded snout. Eyes large and protuberant, the horizontal diameter a little less than the length of the snout, limited behind by an oblique fold. An impressed line from the posterior angle of the eye to the lateral extension of the gular fold. Trunk

slender, subcylindrical, marked above with a slight median impressed line. Costal grooves variable, 17-20, the usual number 19, counting 1 in the axilla and 2 that run together in the groin, and 9-11 intercostal folds between the toes of the appressed limbs. Tail long, slender, tapering, and marked with grooves that give it a segmented appearance. The tail may comprise 44-54.3 per cent of the total length in adults, the higher figures associated with the largest specimens. Legs slender, noticeably longer than in *B. p. major*, hind, when appressed to the sides overlapping $5\frac{1}{2}$ - $6\frac{1}{2}$ intercostal folds. Toes 4-4, ball-tipped below

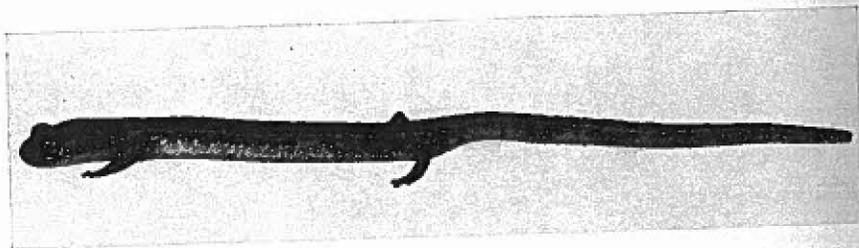


FIG. 93. *Batrachoseps attenuatus pacificus* (Cope). Adult, about natural size. San Miguel Island, California. [Photograph through the courtesy of J. R. Slevin.]

but more nearly normal than in other species of the genus, 1-4-2-3 in order of length from the shortest, the 1st rudimentary, 2nd and 4th nearly equal; toes of the hind feet webbed at base. Nasolabial groove scarcely reaching the edge of the lip, sometimes branched at tip. Tongue small, oval, provided with a pedicel and membrane running to the anterior margin. Vomerine teeth often in a single irregular row of 7-10 teeth, sometimes in short double series or irregular patches which arise behind the inner margin of the inner naris and slant inward and backward toward the mid-line, where they are narrowly separated. Parasphenoid teeth sometimes in 2 slender elongate patches narrowly separated, or in a single broad patch narrowed anteriorly and separated from the vomerine series by about 3 times the diameter of a naris.

COLOR. The general color resembles that of *B. p. major* in that the dorsal surfaces are dark and the ventral light; but there is considerable variation. The San Miguel specimens I have examined resemble *major*

closely and have the ventral pigmentation in fine specks like that subspecies. In some Santa Cruz specimens the dark pigment of the venter forms a reticulated pattern like that of *B. a. attenuatus*, and there is an indication of a dorsal band, but the legs are longer and larger and the head wider and larger. Other individuals from Santa Cruz have the pigment of the venter in fine specks like *B. p. major*. In preserved specimens, the dorsal color becomes purplish-brown, with the legs, head, and tail somewhat lighter. The color fades slightly on the lower sides to the pale venter.

BREEDING. Nothing definite is known. A large female from San Miguel Island, No. 45226 in the collection of California Academy of Sciences, had ovarian eggs 2 mm. in diameter when captured May 20, 1919.

ALASKA WORM-SALAMANDER. *Batrachoseps caudatus* Cope. Fig. 94. Map II.

TYPE LOCALITY. Hassler Harbor, Alaska.

RANGE. KNOWN only from the type locality and doubtfully from Yukatat Bay.

HABITAT. Nothing has been published. Stejneger and Barbour (1939, p. 18) believe that the type may have been taken on Anette Island in southeastern Alaska.

SIZE. The type, U.S.N.Mus. No. 13561, is the only specimen in condition to be measured, and, with the passage of time, its dimensions seem to have changed somewhat. In Cope's original account the total length is given as 160 mm., tail 103 mm. (1889, p. 126). Dunn (1926, p. 234) has the total length 165 mm., tail 110 mm. I have recently examined the specimen and my measurements are as follows: total length $6\frac{25}{32}$ " (172 mm.), tail $4\frac{3}{16}$ " (107 mm.); head length $1\frac{1}{2}$ " (9 mm.), width $\frac{7}{32}$ " (5.5 mm.).

DESCRIPTION. The head is narrow, the sides behind the eyes gently converging to the lateral extensions of the gular fold, in front converging more abruptly to the bluntly pointed snout. Eyes moderate, the horizontal diameter a little less than the snout. A slightly impressed line

from the posterior angle of the eye to the lateral extensions of the gular fold, a vertical groove from this line to the angle of the mouth, and another groove to the angle of the jaw. The trunk is slender and well rounded. There are 21 costal grooves, and 12 intercostal folds between the toes of the appressed limbs. Tail long, slender, tapering, and comprising 62.2 per cent of the total length. Legs slender. Toes 4-4, those

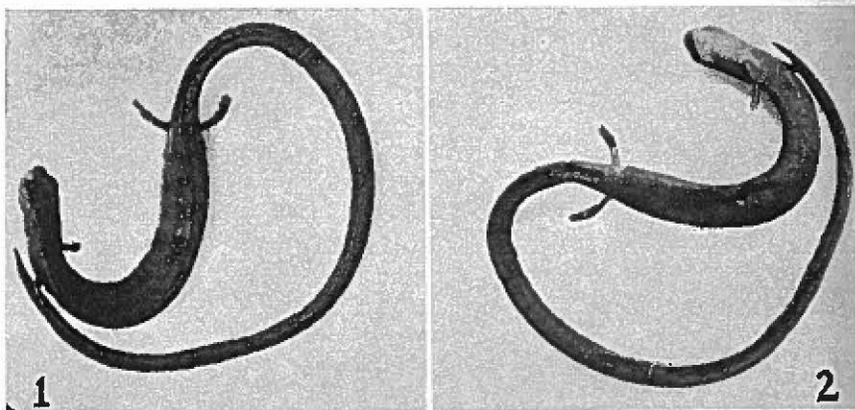


FIG. 94. *Batrachoseps caudatus* Cope. (1) Type; adult female, dorsal view. (2) Same, ventral view. Hassler Harbor, Alaska. [Photograph from the U.S. National Museum.]

of the hind feet 1-4-2-3 in order of length from the shortest, 1st very short and webbed to tip. Toes of the fore feet 1-4-2-3, 1st within web. Tongue small, oval. Vomerine teeth in short double series which arise behind inner margin of inner naris and slant inward and backward toward the mid-line, where they are narrowly separated. Parasphenoid teeth in 2 elongate separate patches.

COLOR. The color at the time of Cope's description (1889, p. 126) was given as follows: "The general color is brown. It is deeper on the sides to a line on each side of the back and on the anterior half of the abdomen and on the superior surface of the distal part of the tail. Gular region and chin yellowish." At the present time (January 1941) the colors are about as follows: dark brown above, lighter below, the dorsal pattern consisting of small round spots which form a finely reticulated pattern.

Venter finely reticulated, the network of dark lines enclosing nearly circular spots.

BREEDING. Nothing is known.

GENUS ANEIDES

KEY TO THE SPECIES AND SUBSPECIES OF ANEIDES

1. Ground color above black, or black with yellowish green blotches 2
 Ground color not as above 3
2. Ground color above black; belly black or dark slate; back and sides with small, scattered, whitish or yellowish specks (often fading in preservatives); soles of feet light; vomerine series short, 3-5; toe tips bluntly rounded and only slightly widened; 3½-5 intercostal folds between toes of appressed limbs; length to 5 15/16" (152 mm.). Santa Cruz County, California, northward in the Coastal Range to the Klamath Mountains *flavipunctatus* p. 336
 Ground color above black (fades to brown with dull tan markings in preservatives), with yellowish-green lichen-like markings; base of legs above with a spot of bright orange; belly light, yellow to bluish-gray, with a few scattered light flecks; vomerine series 5-9; toe tips transversely widened and squarely truncate; toes of appressed limbs overlap 1-3 intercostal folds; length to 5" (128 mm.). Virginia, West Virginia, Ohio, North and South Carolina, Georgia, Alabama, and eastern Tennessee *æneus* p. 328
3. Ground color above uniform light brown to yellowish- or chocolate-brown, with small whitish or yellowish spots; 15-16 costal grooves; mandibular teeth very large, flattened, sharp-pointed 4
 Ground color above deep brown in a reticulated pattern with a few small, whitish pigment flecks and many small brassy flecks most abundant on the snout and in a median dorsal band; base of tail above bronzy; venter bluish-gray, with a few scattered whitish flecks; mandibular teeth 5-8 each side, the posterior enlarged and flattened; 16-17 costal grooves; toe tips squarely truncate; length to 5 1/4" (134 mm.). Southern Mendocino County, California, northward to Vancouver Island, British Columbia *ferreus* p. 332
4. Light spots of dorsum and sides few, small, and scattered; vomerine series 5-8; tail long, somewhat prehensile; toe tips slightly expanded; toes of appressed limbs meeting or overlapping 1 intercostal fold; length to 6 3/8" (162 mm.). Southwestern California from Humboldt and San Diego Counties; also from Mariposa and Madera Counties; Coronados Island, Lower California *lugubris lugubris* p. 340
 Light spots of dorsum abundant, varying in size from small flecks to elongate spots 3 or 4 mm. in length; vomerine series 5-11; toe tips

squarely truncate and slightly widened; toes of appressed limbs overlap $1\frac{1}{2}$ -3 intercostal folds; length to $5\frac{3}{32}$ " (130 mm.). South Farallon Island, California *lugubris farallonensis* p. 343

BRONZED SALAMANDER. GREEN SALAMANDER. *Aneides aeneus* (Cope). Figs. 95a-b, 96. Map 39.

TYPE LOCALITY. Nickajack Cave, Tennessee.

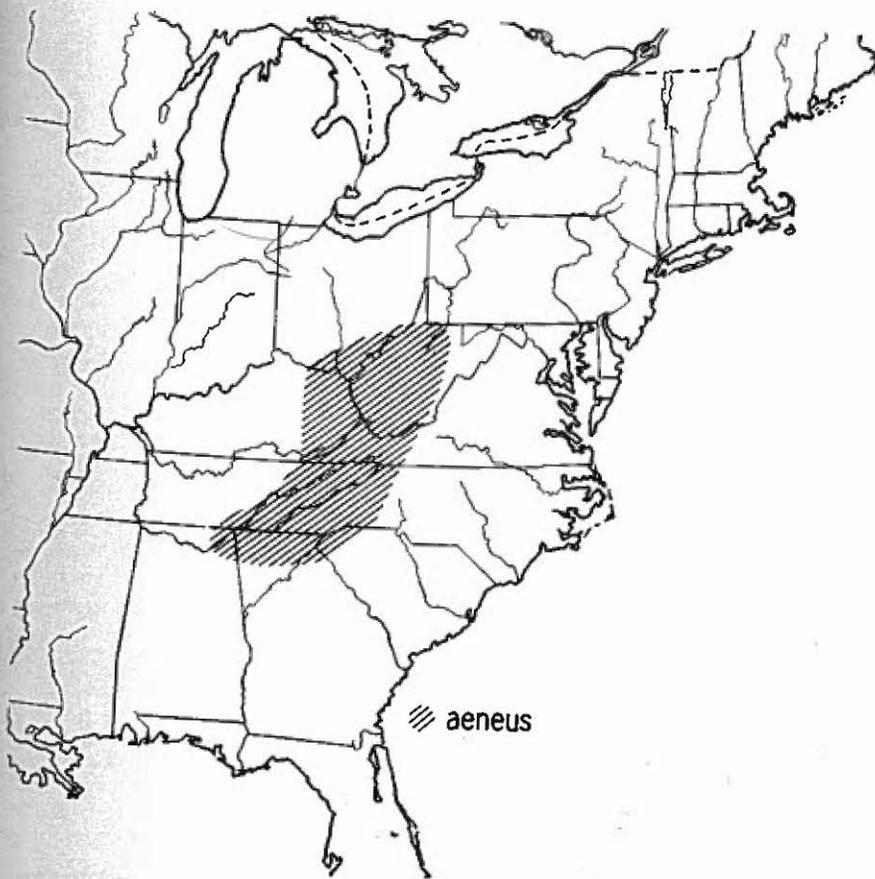
RANGE. Virginia, West Virginia, Kentucky, Ohio, North and South Carolina, Georgia, Alabama, and eastern Tennessee.

HABITAT. Often abundant in crevices of sandstone cliffs, or beneath flakes of rock in fairly dry or damp situations. Sometimes found beneath the loose bark of standing or fallen trees, occasionally in or beneath logs on the ground.

SIZE. The average length of 19 adults of both sexes from Kentucky and West Virginia is 4" (102 mm.), the extremes $3\frac{5}{32}$ " (81 mm.) and 5" (128 mm.). Ten males average $4\frac{3}{32}$ " (104 mm.) and seven females $4\frac{1}{32}$ " (103 mm.). The proportions of an adult male from Elkins, West Virginia, sent me by Mr. N. B. Green, are as follows: total length 5" (128 mm.), tail $2\frac{3}{32}$ " (69 mm.); head length $\frac{5}{8}$ " (16 mm.), width $1\frac{3}{32}$ " (11 mm.). An adult female from the same locality measures: total length $3\frac{5}{32}$ " (81 mm.), tail $1\frac{1}{4}$ " (32 mm.); head length $\frac{1}{2}$ " (13 mm.), width $\frac{5}{16}$ " (8 mm.).

DESCRIPTION. This is a black salamander with yellowish-green, lichen-like blotches and expanded toe tips. The head is widest immediately back of the eyes, where, in the adult male, it is somewhat swollen; the sides behind the eyes converging slightly to the lateral extensions of the gular fold, in front tapering more abruptly to the truncated snout. Eyes large and strongly protuberant, the pupil horizontally elliptic, the iris golden. A sinuous impressed line from the posterior angle of the eye to the lateral extension of the gular fold; a short vertical groove from this extending behind the angle of the jaw. Gular fold well developed. Trunk rounded above, flattened below. The costal grooves usually 14; or 15 counting 1 in the axilla and 2 that run together in the groin. Toes

of appressed legs overlapping 1-3 intercostal folds. Tail slightly flattened at base above, nearly circular in section beyond base, slender and tapering. Legs well developed, the animal capable of leaping 2 or 3 times its length. Toes 5-4, those of the hind feet 1-2-5-(3-4) in order of



MAP 39.—Distribution of *Aneides aeneus*.

length from the shortest; 1st toe very short and nearly enclosed by web; others webbed $\frac{1}{2}$ the length. Toes of the fore feet 1-2-4-3, the 1st enclosed in the web, others webbed at base. Toe tips transversely widened and squarely truncate. Tongue heart-shaped, free at sides only, the surface finely papillose. Vomerine teeth in series usually varying in number,

in different individuals, from 5 to 9. The series arise behind the middle of the inner nares and curve gently inward and backward toward the

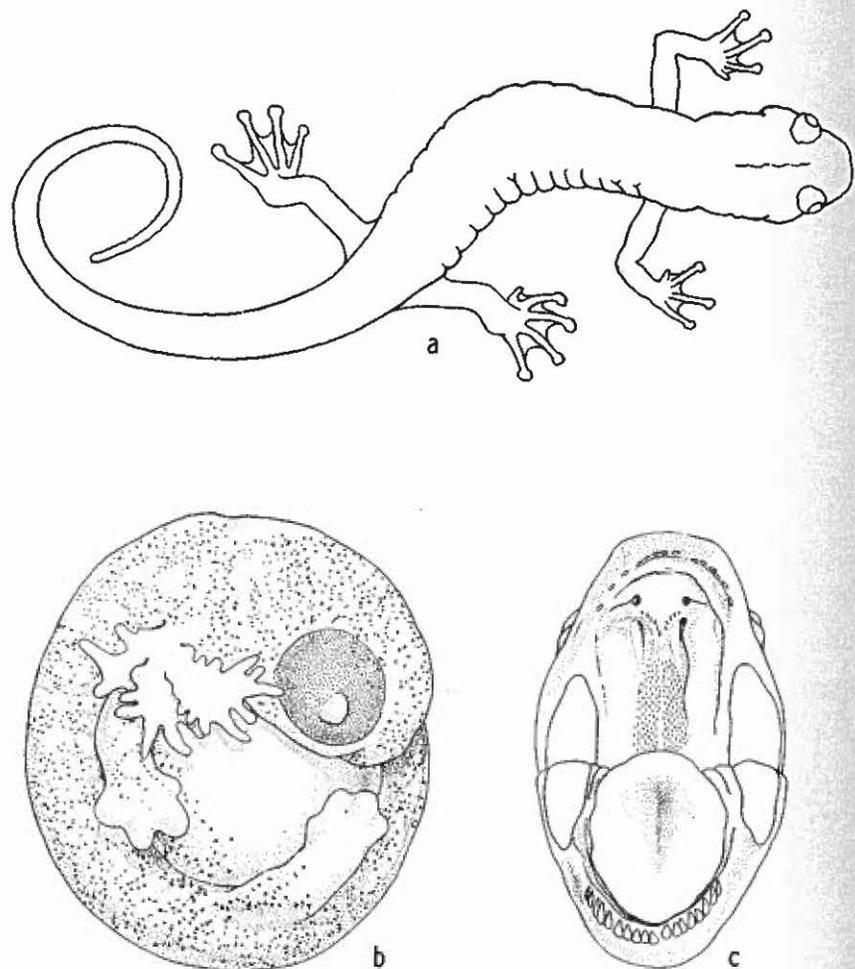


FIG. 95. (a) Outline of *Aneides aneus* to show the form of the body and the character of feet and toes. [H.P.C. del.] (b) Encapsulated larva of *Aneides aneus*. (c) Mouth parts of *Aneides lugubris lugubris* to show the character of tongue and teeth. [b, c, M.L.S. del.]

mid-line, where they are separated by about the width of an inner naris. Parasphenoid teeth may form a single patch, wide behind, narrowed in front, or 2 elongate groups narrowly separated; occasionally the patches

may be separate behind and contiguous anteriorly. Teeth on maxillary extending to behind margin of inner naris, rest of maxillary sharp-edged. Teeth on mandible limited to anterior $\frac{2}{3}$, those on the sides enlarged

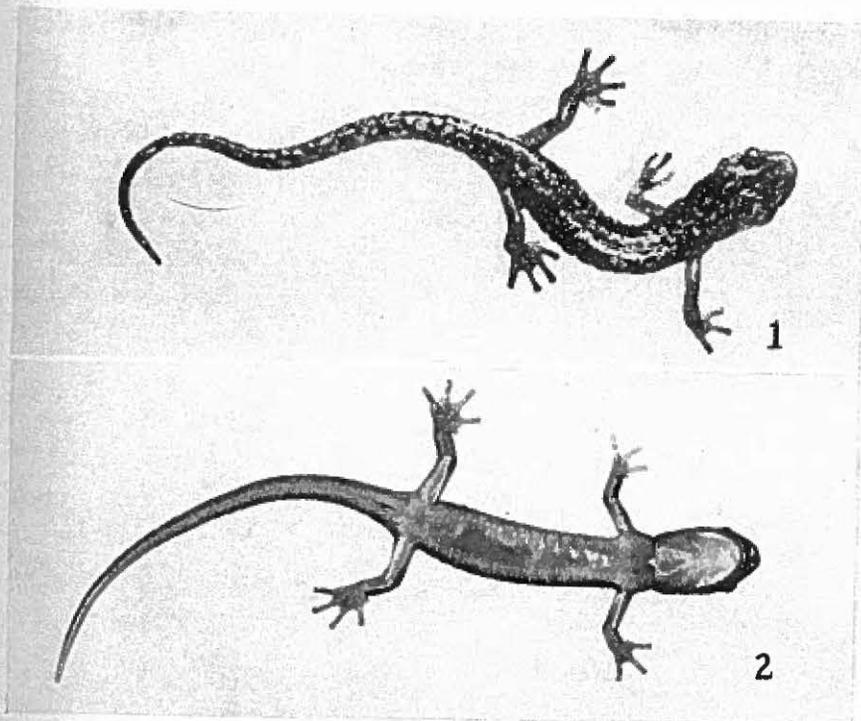


FIG. 96. *Aneides aneus* (Cope). (1) Adult male, actual length 5" (127 mm.). (2) Adult male, another individual; actual length $4\frac{1}{16}$ " (122 mm.). Near Elkins, West Virginia.

and flattened. Vent of male with fine papillae within lips anteriorly; vent of female smooth within.

COLOR. The general ground color is black, marked above with yellowish-green, lichen-like patches; on the sides the patches are fewer, smaller, and more widely scattered. At the base of the legs above, a bright orange patch; rest of legs blotched with greenish-yellow. Head generally darker than body and with a few small, whitish points among the larger patches. Belly light yellow to bluish-gray, with a few scattered light flecks. Lower

surface of legs, throat, and tail pale yellowish-gray, the throat with many small irregular light spots.

BREEDING. Nothing is known of the mating habits, but eggs have been discovered a number of times and the encapsulated larvae described. Eggs were first reported by Pope (1928, p. 6). On July 23, 1937, an irregular cluster of 14 was discovered in the cavity of a prostrate water-oak limb near Pine Mountain, Kentucky. The eggs adhered to one another by the adhesiveness of the outer envelopes and were attached to the side of the cavity by 4 short mucous cables. In color they were dirt-brown with a tinge of yellow, perhaps stained by the rotting wood. Individual eggs with their envelopes have an outside diameter of about 5 mm. The egg itself is a light yellow sphere provided with two envelopes, the inner thin and resistant, the outer soft and thick (Pope, *ibid.*, p. 10). On Aug. 19, 1937, Mr. Leslie Hubricht collected a lot of 19 eggs on the north side of Pine Mountain, Kentucky. These eggs, with embryos well formed, had a long diameter of 5 mm. and a short diameter of 4 mm. The embryo was surrounded by 2 thin envelopes only. Gentry (1941, p. 329) reported the discovery of a female with a cluster of eggs on Sept. 5, and again on Sept. 6, in the Obey River drainage in Tennessee.

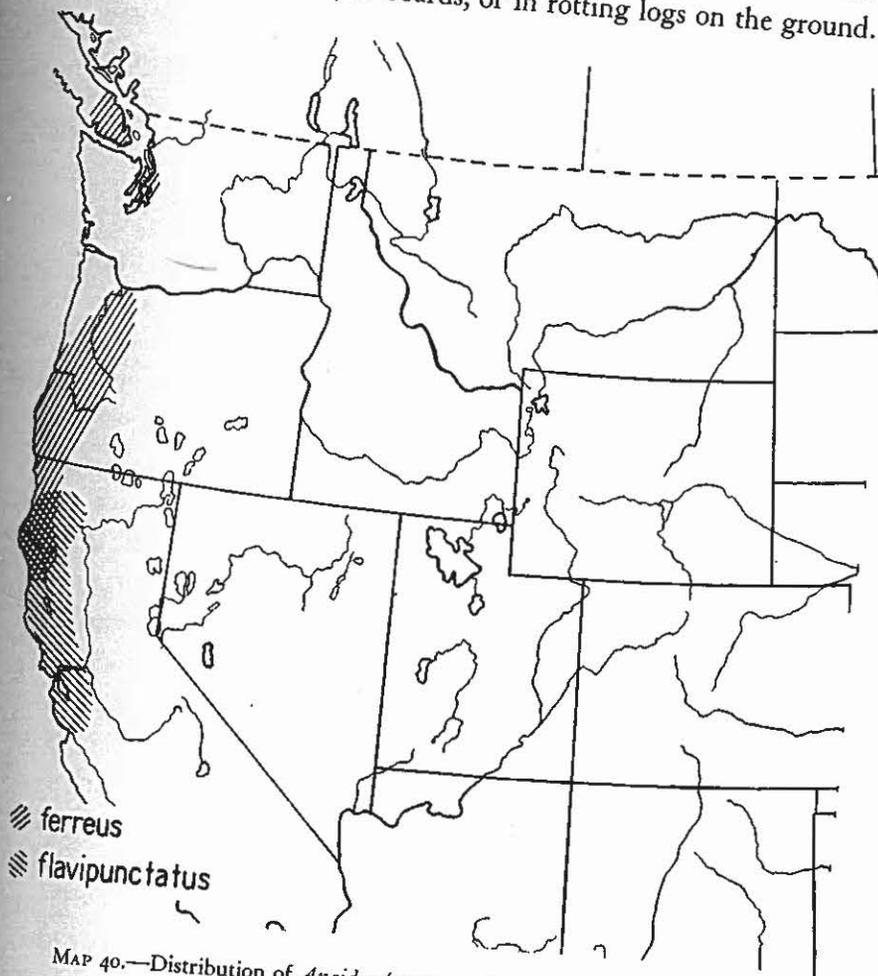
From evidence presented by Walker and Goodpaster (1941, p. 178) it is likely that the young remain with the guardian parent some time after hatching. Groups of young were twice found, each with an attending adult female. The first lot found numbered 13, the second 17, the size ranging from 21.5 to 24.8 mm. These are the smallest specimens so far reported. The young lacked gills and exhibited a color pattern similar to that of adults. The large size of the external nares is a striking characteristic of the recently hatched young.

CLOUDED SALAMANDER. RUSTY SALAMANDER. *Aneides ferreus* Cope. Fig. 97. Map 40.

TYPE LOCALITY. Fort Umpqua, Oregon.

RANGE. Southern Mendocino County, California, northward to Vancouver Island and smaller islands near by, British Columbia.

HABITAT. While not as arboreal in habit as *A. l. lugubris*, this species has sometimes been found living in the rotten wood of standing trees 20 feet above the ground. The majority of specimens have been taken from beneath logs, bark, or boards, or in rotting logs on the ground.



MAP 40.—Distribution of *Aneides ferreus* and *A. flavipunctatus*.

SIZE. Reaches an extreme length of about $5\frac{1}{4}$ " (134 mm.). Five adults of both sexes from Bayne Island, Union Bay, British Columbia, average $3\frac{2}{32}$ " (98 mm.) and vary from $3\frac{1}{32}$ " (77 mm.) to $4\frac{15}{32}$ " (114 mm.). The largest of this series, a male, has the following proportions: total

length $4\frac{15}{32}$ " (114 mm.), tail $1\frac{5}{8}$ " (42 mm.); head length $2\frac{1}{32}$ " (17 mm.), width $\frac{3}{8}$ " (10 mm.). A female from the same locality measures: total length $4\frac{1}{32}$ " (103 mm.), tail $1\frac{1}{16}$ " (43 mm.); head length $\frac{5}{8}$ " (16 mm.), width $\frac{3}{8}$ " (10 mm.).

DESCRIPTION. The head is widest midway between the eye and the lateral extension of the gular fold, the sides behind this point constricted to the neck, in front tapering to the bluntly pointed truncated snout. In side view, snout obliquely truncated. Eyes large, protuberant, the iris dark, tinged with brassy above the pupil, limited behind by a vertical groove. An impressed line from the posterior angle of the eye to the lateral extension of the gular fold. A short vertical groove from this line passing behind the angle of the mouth. Trunk with a median dorsal impressed line, rounded on the sides, flattened below; 16-17 costal grooves, counting 1 each in the axilla and groin, and $1-1\frac{1}{2}$ intercostal folds between toes of appressed limbs. Tail broadly oval in section at base, nearly circular in section at mid-length, slightly compressed distally, and evenly tapering to the tip. Legs stout. Toes 5-4, those of the hind feet 1-(2-5)-3-4 in order of length from the shortest, the first small but free, others webbed at base; toes of the fore feet 1-4-2-3, scarcely webbed at base. Toes, except the 1st, all transversely widened at tip and squarely truncated. Tongue large, filling the floor of the mouth, thick and fleshy, wider behind than in front, free at the sides. Vomerine teeth in short series of 4-4 to 6-6 or 6-7, which arise behind the inner margin of the inner naris, curve obliquely inward and backward to the mid-line, where they may meet or be narrowly separated. Parasphenoid teeth in a single broad patch slightly narrowed anteriorly and separated from the vomerine by about the length of a vomerine series. Premaxillary teeth not greatly enlarged but sometimes perforating the lips in the male. Maxillary teeth few (usually 3 or 4), somewhat enlarged and flattened, and extending only to a point opposite anterior angle of eye. Mandibular teeth 5-8 on each side, the posterior enlarged, flattened.

COLOR. The general ground color above is dark brown, overlaid by

large, irregular, grayish blotches which have a brassy tinge. There is considerable variation in the blotching, but in some specimens the head is mostly grayish with the exception of a dark central area, a dark bar

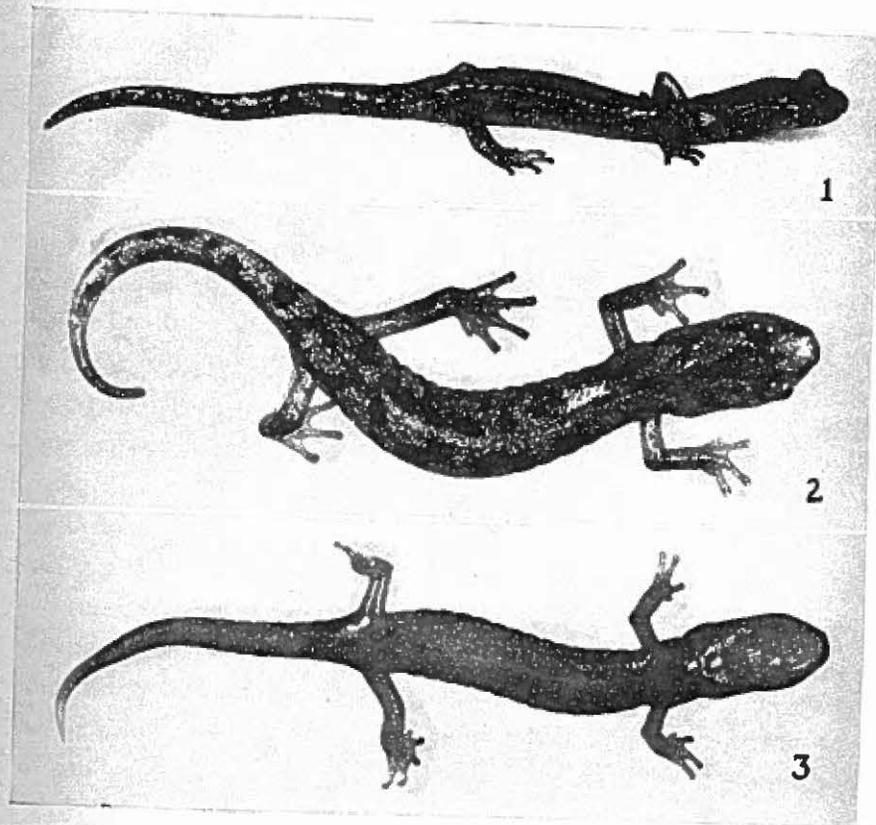


FIG. 97. *Ancides ferreus* Cope. (1) Adult, dorsolateral view; actual length about $4\frac{1}{16}$ " (120 mm.). Comptche, Mendocino County, California. [Photograph by J. R. Slevin.] (2) Adult female, actual length $3\frac{1}{8}$ " (80 mm.). (3) Same, ventral view. Mill Creek, near Crescent City, Del Norte County, California. [W. F. Wood, collector; from A. H. Wright.]

from the nostril to the eye, and dark pigment following the impressed line which extends from the posterior angle of the eye to the lateral extension of the gular fold. The legs are generally light, with a few brownish patches. The venter is light bluish-gray, with many very small, light yellow flecks scattered generally over the surface except, rarely,

on the ventral surface of the tail. In a juvenile specimen, 46 mm. long, from near Tidewater, Oregon, the colors are essentially as follows: The general ground color is black, mottled and marbled with bronze, the bronze concentrated on the snout in a patch extending to the eyes, in an elongate spot on either side of the neck above the insertion of the arms, on the basal half of the proximal segments of the limbs, and along the dorsal surface of the tail. The sides are strongly mottled bronze and black, the belly uniformly bluish-gray with minute white flecks. The vent of the male is lined with papillae, anteriorly.

BREEDING. Nothing is known of the mating habits. Slevin (1928, p. 71) reported that two females collected on Bayne Island, British Columbia, May 16, 1906, had pigmentless, ovarian eggs 4 mm. in diameter, and Fitch (1936, p. 638) mentions a female taken May 22, 1935, in the Rogue River basin, Oregon, which contained 12 ovarian eggs, also about 4 mm. in diameter. The first account of eggs deposited under natural conditions is that of Dunn (1942, p. 52). A cluster of 9 eggs, accompanied by a female, was found Aug. 16, 1941, near Patrick Creek, Del Norte County, California, at an altitude of 2000'. The eggs were attached separately to a bit of bark of a fallen Douglas fir and measured approximately 6 mm. in diameter. A single egg opened by Dunn had 2 envelopes which enclosed a well developed young about 15 mm. long. The young salamander had a single, leaf-like, allantoic gill on each side and still retained considerable yolk.

BLACK SALAMANDER. SHASTA SALAMANDER. *Aneides flavipunctatus* (Strauch). Fig. 98. Map 40.

TYPE LOCALITY. New Albion, California (probably in Sonoma County).

RANGE. Santa Cruz County, California, northward in the Coastal Range to the Klamath Mountains.

HABITAT. Wood (1936, p. 171; 1939, p. 110) found this species most abundant in burnt-over areas in the southern redwood forests, under

charred logs and slabs, and in the higher fir and pine forests of the outer Coast Ranges. It is not limited to such situations, for Van Denburgh (1895, p. 776) wrote that it had been "found under boards, decaying logs, and stones in the vicinity of running water, and in the drain from a spring"; and we have collected it near Fort Ross, California, from beneath loose stones and small rock slabs at the edge of a stream in a deeply shaded gully.

SIZE. Attains a length of $5\frac{15}{16}$ " (152 mm.). The average length of 16 adults of both sexes is $4\frac{1}{2}$ " (115 mm.), the extremes $3\frac{1}{2}$ " (85 mm.) and $5\frac{1}{2}$ " (141 mm.). An adult male from 9 miles south of Fort Ross, California, has the following measurements: total length $5\frac{3}{32}$ " (130 mm.), tail $2\frac{1}{32}$ " (60 mm.); head length $2\frac{3}{32}$ " (19 mm.), width $1\frac{3}{32}$ " (11 mm.). An adult female from Los Gatos has the following proportions: total length $4\frac{1}{2}$ " (115 mm.), trunk length $2\frac{2}{32}$ " (73 mm.) (tip of tail lost); head length $2\frac{1}{32}$ " (17 mm.), width $\frac{3}{8}$ " (10 mm.).

DESCRIPTION. A black salamander with small whitish or yellowish spots. The head is widest immediately back of the eyes, where, in the male, it is noticeably swollen, the sides behind this point converging gently to the lateral extensions of the gular fold and in front abruptly to the bluntly pointed snout. Eyes only moderately large and protuberant, limited behind by a vertical fold. A sinuous fold or groove from the posterior angle of the eye to the lateral extension of the gular fold, a slightly impressed line from this to behind the angle of the jaw. Gular fold well developed. Trunk slightly depressed and with an impressed median dorsal line. Costal grooves strongly developed, variable in number but usually 14, sometimes 15 when 2 that run together in the groin are counted separately, rarely 16, and $3\frac{1}{2}$ -5 intercostal folds between the toes of the appressed limbs. Tail stout, flattened above at base, beyond to distal third, nearly circular in section, slightly compressed distally. Legs stout, noticeably shorter than in other species of the genus, as indicated by the greater number of folds between the appressed toes. Toes 5-4, short, those of the hind feet 1-5-2-4-3 or 3-4 in order of

length from the shortest, the innermost rudimentary but with the tip free, others webbed at base; toes of the fore feet 1-4-2-3. Toes only slightly widened at the tips and bluntly rounded. Tongue large, filling the floor of the mouth, broadly rounded behind, narrower and bluntly pointed in front, its surface with fine villae; free at the sides and slightly at the rear. Vomerine teeth in short series of 3-3 to 5-5. The series arise

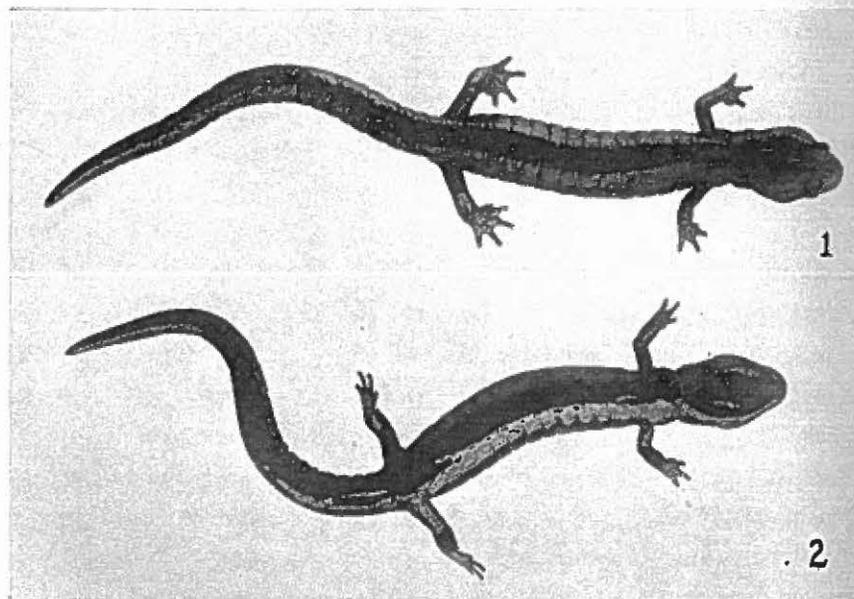


FIG. 98. *Ancides flavipunctatus* (Straugh). (1) Adult male, actual length $5\frac{1}{4}$ " (130 mm.). (2) Same, ventral view. Near Fort Ross, California. The apparent middorsal and midventral stripes are due to reflection from adjoining surfaces.

behind or just inside the inner margin of the inner naris and slant obliquely inward and backward toward the mid-line, where they are separated by about the width of a naris. The parasphenoid teeth usually form a single broad patch which is slightly narrowed anteriorly and separated from the vomerine by about the distance between the nares. Premaxillary teeth not enlarged, but with the tips perforating the edge of the lip; maxillary teeth enlarged, 2-4 in number, angular in section; mandibular teeth 3-4 on each side, enlarged, thickened anteriorly,

knife-edged behind. The vent of the male is lined with papillae in front; that of the female with oblique folds.

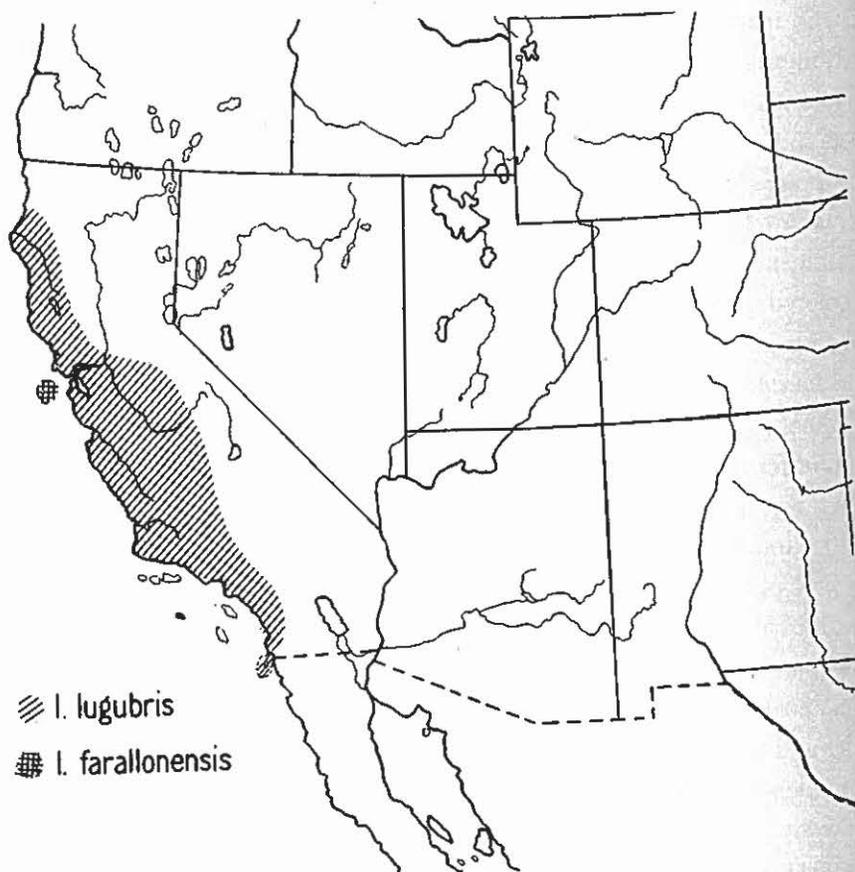
COLOR. In the specimen from near Fort Ross, California, the general color above is black. Scattered over the dorsum and sides are a few small straw-yellow spots. A few light spots are present on the back of the head and on the upper surface of the limbs. The belly is deep slate with many minute points of light gray. The under surface of the head from the point of the jaw to the angle of the mouth, lighter gray. Gular fold whitish, soles of feet grayish, tinged with flesh. A young individual, 50 mm. long, in life had the dorsal surface of the head, trunk, and tail bronzy-green, the upper sides black. Scattered over back and sides were many small silvery-white points, and the upper surface of the basal segment of the legs was golden-yellow. The ventral surfaces were colored as in the adult. Adults south of San Francisco Bay are said to be unspotted (Myers, 1930, p. 60).

BREEDING. Nothing is known of the mating habits. Van Denburgh (1895, p. 776), the first to report the eggs of this species, received an adult female and eggs from Los Gatos, California, July 23, 1895. "Each egg was about 6 mm. in diameter, almost spherical, and inclosed in a thin, tough, gelatinous sheath. Each of these sheaths was drawn out, at one place, into a slender peduncle, which was attached to a basal mass of the same gelatinous substance. In this way, each egg was at the end of an individual stalk, and all were fastened to a common base. This base had evidently been anchored to a stone or lump of earth." The salamander and about 30 eggs had been found beneath a platform in dry earth at a depth of 15" or more. A specimen killed July 30, 1895, was found to contain 25 large ovarian eggs and many minute ones. Storer (1925, p. 123) also reported the discovery of a female and seven pedunculated eggs found at Laytonville, California, July 1, 1913. This batch was found 9" below the surface of the ground in a cellar. The eggs were deposited in a group and attached by their peduncles to the damp earth. After long preservation they measured 5.9-6.4 mm. in diameter, being elongated in the direction of the peduncle.

ARBOREAL SALAMANDER. *Aneides lugubris lugubris* (Hallowell). Figs. 95c, 99. Map 41.

TYPE LOCALITY. Monterey, California.

RANGE. Mainly confined to western California from Humboldt County



MAP 41.—Distribution of the subspecies of *Aneides lugubris*.

to San Diego County; also from Mariposa and Madera Counties; Anno Nuevo Island, Monterey Bay; Coronados Island, Lower California.

HABITAT. This species is found both on the ground and in the trees. When on the ground it often hides in logs and stumps or beneath sur-

face materials such as stones, logs, bark, and boards. On the University of California campus at Berkeley, many individuals were found occupying the cavities in the "live oak" trees, some at a height of 30' above the ground. The eggs have been discovered both in the soil and in the cavities of trees.

SIZE. Attains an extreme length of $6\frac{3}{8}$ " (162 mm.). The average length of 12 adults of both sexes is $4\frac{19}{32}$ " (118 mm.), the extremes $3\frac{13}{32}$ " (87 mm.) and $5\frac{19}{32}$ " (143 mm.). An adult male from Berkeley, California, has the following measurements: total length $5\frac{9}{16}$ " (142 mm.), tail $2\frac{17}{32}$ " (65 mm.); head length $2\frac{9}{32}$ " (21 mm.), width $\frac{1}{2}$ " (13 mm.). An adult female measures: total length 5" (128 mm.), tail $2\frac{15}{16}$ " (59 mm.); head length $2\frac{3}{32}$ " (19 mm.), width $\frac{1}{2}$ " (13 mm.).

DESCRIPTION. The head is large, wider than the trunk, widest at the angle of the jaws, where it is swollen above, the sides behind this point converging to the gular fold and in front more abruptly to the bluntly rounded snout. The eyes are large and prominent, limited behind by a vertical groove. An impressed sinuous line from the posterior angle of the eye bends down posteriorly to join the gular fold. Gular fold strongly developed. Trunk subcylindrical. Usually 15 costal grooves, counting 1 each in the axilla and groin, rarely 14 or 16, the toes of the appressed legs just meeting or overlapping one intercostal fold. Tail long, somewhat prehensile, comprising 42-46 per cent of the total length, broadly oval in section at base, becoming slightly compressed distally; tail with impressed vertical lines on the sides. Legs large, stout, as befitting a climbing animal. Toes 5-4, those of the hind feet 1-5-2-(3-4) in order of length from the shortest; toes of the fore feet 1-4-2-3, the 2nd and 4th about equal; tips of toes only slightly expanded. Commissure of the mouth straight and horizontal to below the eye, then sharply deflected upward. Tongue large, filling the floor of the mouth, the margins thin, the surface spongy, free at the sides and behind. Vomerine teeth 5-8 in short series that arise behind the inner margin of the inner naris and bend sharply backward toward the mid-line, where they are separated

by about $\frac{1}{2}$ the diameter of a naris. Parasphenoid teeth usually in a single patch, wide behind, narrow in front, and separated from the vomerines by about 3 times the diameter of a naris; occasionally in 2 narrowly separated patches. Premaxillary teeth enlarged and somewhat flattened; maxillary teeth 6-8, the series extending to a point op-

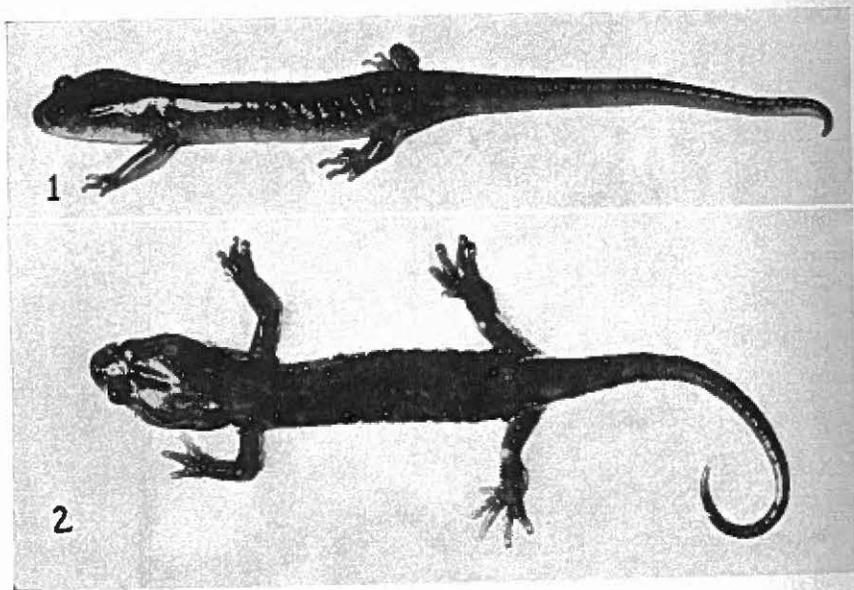


FIG. 99. *Aneides lugubris lugubris* (Hallowell). (1) Adult male, actual length $5\frac{1}{4}$ " (134 mm.). (2) Same, dorsal view. Berkeley, California.

posite the anterior angle of the eye. Mandibular teeth 5-7 in each series, very large, flattened, sharp-pointed, and directed obliquely upward and backward.

COLOR. The general color above varies from a uniform light brown to light chocolate-brown, the upper surface of the tail sometimes brighter. Scattered over the entire dorsal surface of the head, trunk, tail, and limbs, especially in small individuals, are many small whitish or pale yellow spots. In some large specimens the pale spots or flecks are most abundant on the sides of the trunk, thinning out on the back, legs, and base of the tail. The venter is lighter, pale yellow, dull white, bluish-

white, or grayish. The throat and legs are definitely flesh color in some individuals.

BREEDING. The Arboreal salamander is a nocturnal animal, unique among American species in its habit of climbing trees and making use of cavities as retreats and for egg-laying. Ritter (1903, p. 883) was the first to call attention to this interesting habit. The cavities of trees, often extensive, sometimes harbored as many as 35 individuals of various ages, including the young of the year, yearlings, and adults, but often only 1 or 2 salamanders were found. The egg-laying season is during the summer months, eggs having been found from July to September. Individual eggs have a diameter of about 5 mm. and, with their envelopes, from 6 or 7 to 9.5 mm. Whether in cavities in trees, buried in the soil, or hidden beneath some sheltering object on the ground, the eggs are usually attended by the female, sometimes by both parents. The eggs number 12-19 and are deposited singly, each attached by a slender stalk, 8-20 mm. long, to the roof of the cavity and twisted about one another. Young on hatching vary in length from 26.5 to 32 mm. in total length, and in general resemble the adult (Storer, 1925, p. 136).

FARALLON SALAMANDER. FARALLON YELLOW-SPOTTED SALAMANDER. *Aneides lugubris farallonensis* (Van Denburgh). Fig. 100. Map 41.

TYPE LOCALITY. South Farallon Island, San Francisco County, California.

RANGE. This subspecies is known only from the type locality.

HABITAT. The mainland form is more or less arboreal, but in the absence of any considerable number of trees on South Farallon Island, this subspecies is mainly terrestrial. It has been found beneath boards and piles of loose stones in moist situations.

SIZE. In a fine series from the California Academy of Sciences, loaned by Mr. Joseph R. Slevin, 8 males averaged $3\frac{3}{32}$ " (101 mm.) and varied from $3\frac{1}{4}$ " (83 mm.) to $4\frac{2}{32}$ " (124 mm.); 5 adult females averaged $4\frac{1}{8}$ " (105 mm.), the extremes $3\frac{2}{32}$ " (93 mm.) and $4\frac{5}{16}$ " (110 mm.). The proportions of an adult male are as follows: total length $4\frac{7}{32}$ " (108

mm.), tail $1\frac{25}{32}$ " (46 mm.); head length $\frac{25}{32}$ " (20 mm.), width $\frac{3}{8}$ " (10 mm.). A female has the following measurements: total length $4\frac{7}{32}$ " (108 mm.), tail $1\frac{3}{4}$ " (45 mm.); head length $1\frac{1}{16}$ " (18 mm.), width $1\frac{3}{32}$ " (11 mm.). Storer (1925, p. 141) records a specimen $5\frac{3}{32}$ " (130 mm.) in total length.

DESCRIPTION. The head is widest at the angle of the jaws, where it is somewhat swollen above, the sides behind this point converging to the lateral extension of the gular fold and in front abruptly to the bluntly pointed snout. The snout strongly depressed and in side view obliquely truncated, the commissure of the mouth sinuous, bent sharply upward from below the eye. The eyes are large and protuberant, the horizontal diameter about $1\frac{1}{4}$ in the snout, limited behind by a vertical fold. An impressed sinuous line from the posterior angle of the eye to the gular fold. The trunk is somewhat flattened and has a slightly impressed median line. There are usually 15 costal grooves, counting 1 in the axilla and 2 that run together in the groin. The tail is subcylindrical, becoming slightly compressed distally. In the males the tail comprises 40.4-45.16 per cent of the total length, and in the female 41.7-45.16 per cent. The legs are long and moderately stout, and, when appressed to the sides, the toes overlap $1\frac{1}{2}$ -3 intercostal folds. The hind leg itself overlaps, on the average, 9 costal folds as compared with 8 in *Aneides l. lugubris*. Toes 5-4, those of the hind feet slender, square-tipped, 1-2-5-3-4 in order of length from the shortest, the 3rd and 4th about equal, all webbed at base; toes of the fore feet 1-4-2-3 or 1-2-4-3, the tips slightly widened or squarely truncate, webbed at base. Tongue broadly oval in outline, free at the sides and behind, the margins thin, the surface with fine plicae which diverge slightly from the posterior field. Mandibular teeth enlarged, flattened, and triangular. Vomerine teeth 5-11, average 7, in series that arise behind the inner margin of the inner nares and curve inward and backward toward the mid-line, where they may be nearly in contact or separated by about the width of a naris. Parasphenoid teeth in a single patch, broad at the middle of its length and pointed anteriorly, or in 2 narrow patches imperfectly separated.

COLOR. The color above varies from seal-brown to yellowish-brown (turning purplish-brown in preservative), darkest along the middle of the back, fading slightly on the lower sides, and lightest on the snout and legs. This subspecies is much more strongly spotted than the main-

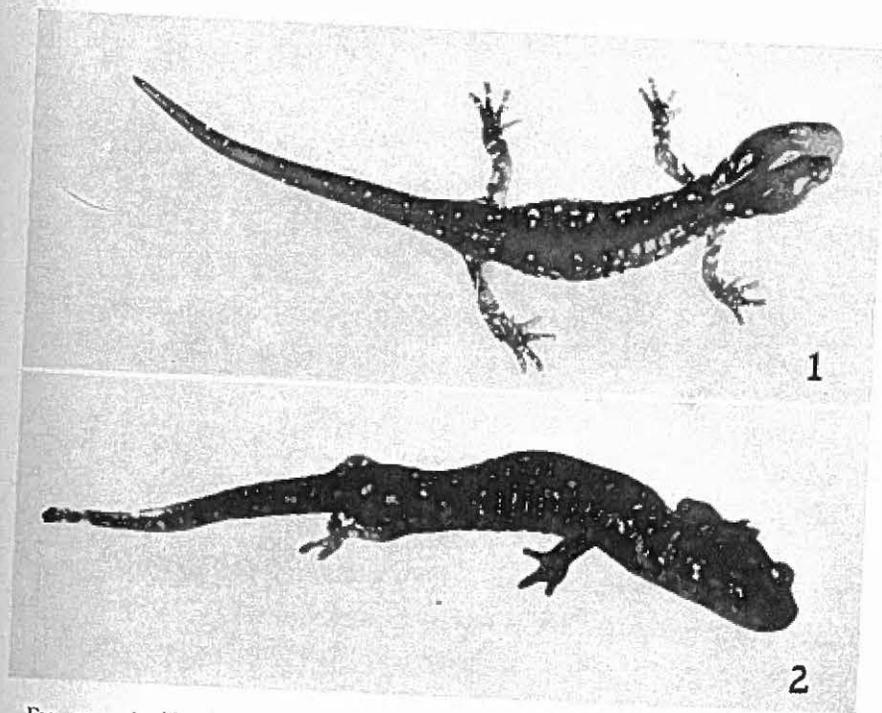


FIG. 100. *Ancides lugubris farallonensis* (Van Denburgh). (1) Adult male, photograph from preserved specimen; actual length $4\frac{27}{32}$ " (124 mm.). South Farallon Island, California. [J. R. Slevin, collector.] (2) Adult, from life. South Farallon Island, California. [Photograph through the courtesy of J. R. Slevin.]

land form, the spots of pale yellow varying in size, from mere specks to elongate blotches 3-4 mm. in length, and distributed generally over the dorsal surfaces but usually fewer on the head and tail. On the sides the light spots extend to the level of the legs and involve the sides of the neck and tail and the upper surface of the limbs. The ventral surfaces are pale yellowish or whitish, the tips of the toes reddish.

BREEDING. Nothing has been made known of the breeding habits, and

the eggs and recently hatched young have not been described. Storer (1925, p. 142) gives some indication of the rate of growth, based on measurements of 11 individuals taken Oct. 26, 1922. "They range from 39 to 126 mm. in total length. Three which measure 39 and 40 mm. are undoubtedly of the 1922 brood. . . . One with a blunt (regenerated?) tail, 53 millimeters in total length, and a normal individual 62 millimeters long, are taken to represent the 'yearling' class. Five others 101 to 112 millimeters in length are either three or four years of age and one is 126 millimeters and hence four or five years old."

GENUS STEREOCHILUS

MARGINED SALAMANDER. *Stereochilus marginatus* (Hallowell). Figs. 101c-d, 102. Map 42.

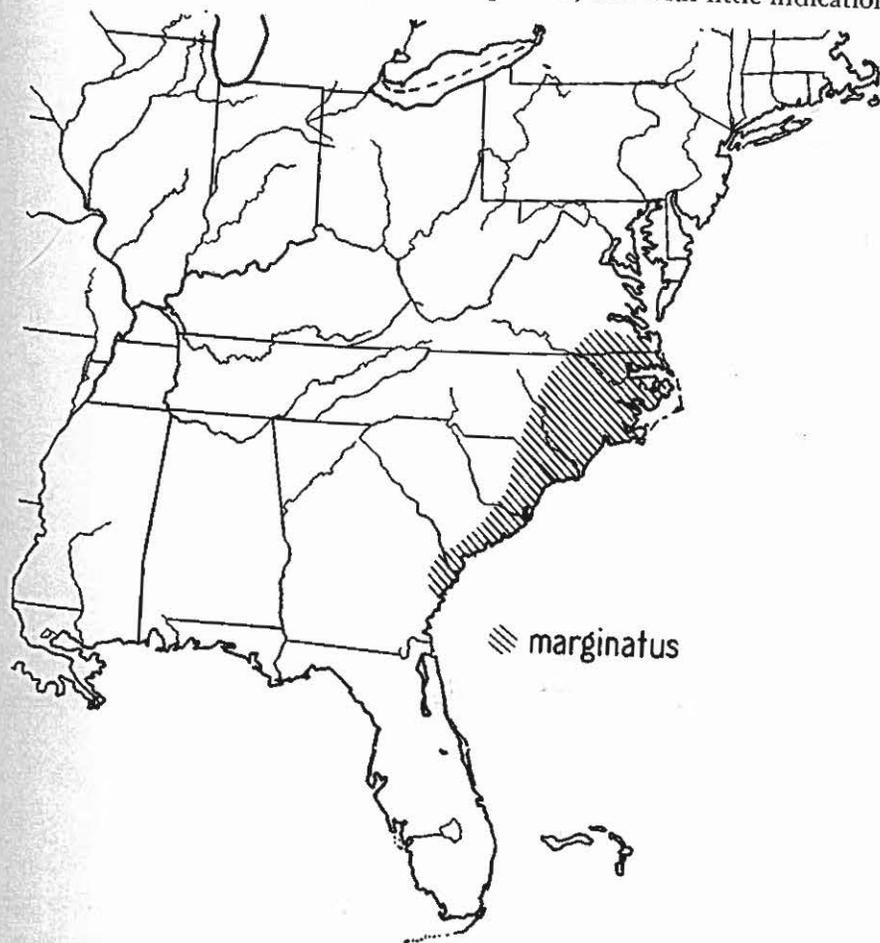
TYPE LOCALITY. Liberty County, Georgia.

RANGE. Petersburg and the Dismal Swamp, Virginia, to Liberty County, Georgia, in the Coastal Plain (Stejneger and Barbour, 1939, p. 20).

HABITAT. Usually aquatic but occasionally found on land under logs in damp situations. They are perhaps most abundant in pools and slow streams in swampy woods, and may be collected by raking out the dead leaves and other bottom rubbish. Brady (1930, p. 58) regards this species as characteristic of the pine barrens.

SIZE. In a series of 14 adults measured by Brimley (1909, p. 132) the size range was from $2\frac{3}{16}$ " (65 mm.) to $3\frac{3}{4}$ " (95 mm.), the average length $3\frac{3}{16}$ " (81 mm.). Dunn (1926, p. 245) reports an adult only $2\frac{15}{32}$ " (63 mm.). The proportions of an adult female from Whitakers, North Carolina, taken Oct. 25, 1926, are as follows: total length $3\frac{3}{16}$ " (71 mm.), tail $1\frac{3}{8}$ " (35 mm.); head length $\frac{5}{16}$ " (7 mm.), width $\frac{7}{32}$ " (5.5 mm.). An adult male from Wilmington, North Carolina, July 25, 1907, C. S. Brimley, collector, measures as follows: total length $2\frac{29}{32}$ " (73 mm.), tail $1\frac{5}{16}$ " (33 mm.); head length $1\frac{1}{2}$ " (8 mm.), width $\frac{3}{16}$ " (4.5 mm.).

DESCRIPTION. This is a lithe, active species characterized by the presence of alternating light and dark longitudinal lines on the sides. The head is small, narrow, pointed, and depressed, and with little indication



MAP 42.—Distribution of *Stereochilus marginatus*.

of a constriction at the neck. The sides behind the eyes are nearly parallel and in front converge to the sharp snout. There is a well defined system of pores which form a small group back of the eye and extend forward in a single line above the eye to a point about $\frac{1}{2}$ the distance to the nostril. This series is overlapped at its anterior end by another which lies